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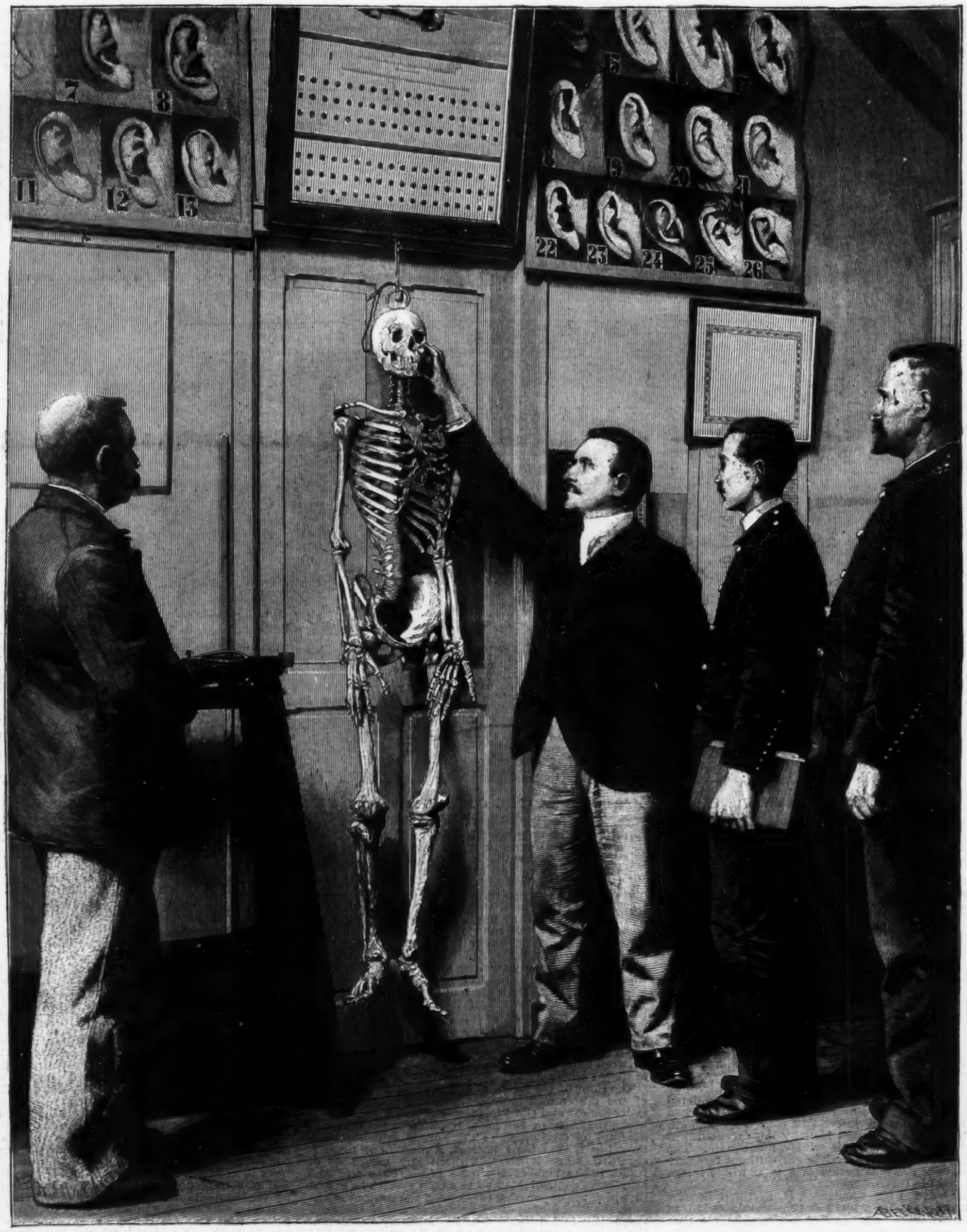


A LESSON IN ANATOMY AT THE SCHOOL OF ANTHROPOMETRY OF THE PREFECTURE OF POLICE, PARIS.

THE SCHOOL OF ANTHROPOMETRY AT THE PREFECTURE OF POLICE.

IN Paris, on the Rue de Harlay, opposite Place Dauphine, is situated the Prefecture of Police, with its various bureaus. Here, after climbing interminable stairways intersected by mysterious corridors, we reach a small, narrow chamber, which is located under the Mansard roof and has somewhat the aspect both of a photographic studio and a schoolroom. Here and there are observed singular accessories, the use of some of which cannot be divined, such as a skeleton draped in green serge and some seats of various forms whence rise graduated rules. Covering the walls, fixed to the inclined ceiling, and fastened to every available space, are seen photographs and drawings of human heads in front view and profile, each accompanied with a number. Black wooden tables and some straw-bottomed chairs serve as furniture for the room. In one corner there is a blackboard covered with odd figures drawn with chalk, and nearby upon a small platform is the professor's chair.

While we are loitering, the class, consisting of about twenty pupils with big mustaches and rather stern faces, begins to arrive. Attentive and serious, all take seats, sharpen their pencils, and the lesson begins.

This is the School of Anthropometry of the Prefecture of Police. The professor is M. Payen, an attache of M. Bertillon's service and one of his most zealous collaborators. The pupils are inspectors newly promoted to the Service de la Sureté, or prison wardens composing the Ecole Penetentiaire Superieure. They attend this course from ten o'clock till noon twice a week for two months. While in the contiguous halls of the Service of Anthropometry and in the photographic gallery the crowd of prisoners that has just arrived at the depot is defiling, the pupils will in this peaceful workroom become profoundly versed in the art of studying physiognomies and isolating the permanent and essential characters of the latter at a glance, and of noting the principal features thereof. In a word, they will become initiated into the art of reading the face. That an exact description of a suspect proves of the utmost importance in the investigation of a crime is a fact that has been recognized ever since the police force has existed. What better guide could there be for the detective following the trail of a malefactor and ordered to find him in a crowd than data that make known to him the most essential peculiarities of the person wanted. The trouble is that up to recent times the art of drawing up and interpreting descriptions has, for want of a good method, remained in a state of infancy.

Thirty years ago, it was thought that photography might supply this want. It has, indeed, rendered great services, but as a means of control solely, when the individual has no interest in concealing himself. For confirming a suspected identity it is excellent, but as a means of research it is wholly inadequate. The most perspicacious "sleuths" might, without recognizing him, pass daily alongside of a type whose image they carried in their pockets.

Struck by such inconveniences, M. Bertillon became desirous of devising a method that should permit of overcoming them. Starting from the principle that the eye sees in things only what it is looking at therein and that it looks at nothing but what it has already an idea, he endeavored to ascertain to what features a detective (whether he had to do with a living subject or a photographic portrait) should direct his special attention, while neglecting the general impression, which signifies nothing, and which a skillful criminal has a hundred means of modifying at his will. In the first place, he must become accustomed to noting accurately what in ordinary life no one thinks of noticing. If a subject is of very tall or very low stature, any one will notice it at once. But such extremes are rare, and, nine times out of ten, if we wish to make known this particular feature, we shall have to say that the individual is of medium height. It is such averages that it is necessary to differentiate. M. Bertillon distinguishes seven categories in all, and these seem to be sufficient. They are as follows: 1, very small; 2, small; 3, small, mean limit; 4, medium; 5, large, mean limit; 6, large; 7, very large.

This division will be reproduced for all the characters to be studied, and will be indicated in the written description by the initials *p*, *m*, *g*, underscored in order to attract particular attention, but put between parentheses to show that the matter is not of so much importance.

But the principal thing is not to measure in this manner one's visual impression. One must know what to look at, and must direct his attention especially to characters upon which neither age nor the arts of the costumer, hair dresser and dyer have any influence.

Cards drawn up by M. Bertillon comprise a large number of measurations and chromatic data; but all questions are not followed by an answer. In fact, the detective notes only what is worthy of remark. All the ordinary features and means are eliminated from this description, since they are common to the majority and could not be used for isolating an individuality.

All characters, moreover, do not possess an equal importance. Anthropometric observations (stature, length and breadth of the head and ear, size of the foot and of the middle finger, little finger and elbow), in order to have a real descriptive value, must be made accurately with instruments of precision.

This sort of observation can therefore be applied only to individuals already arrested, and a complete description of whom it is desired to keep. For the capture of a criminal in flight their aid is of no avail.

The same may be said of the color of the hair and beard, which is easily changed; of the complexion, which may be blotched; and even of the color of the eyes, which it is difficult to determine accurately without a direct light. The detective very often hesitates between two of the seven classes in which the eyes are arranged according to the color of the iris.

The slope of the forehead and the breadth and shape of the nose afford more accurate data; but it is especially the ear and the various peculiarities that it exhibits that furnish the great resource of the officer in his hunt for a criminal. To this organ, which in ordinary life is very little noticed, a prominent place is accorded, since it gives, without any possibility of fraud, indications of the most precise character that are always controllable by the naked eye. The extent to which the upper edge turns over, the contour of the lobe, the model of its surface, the profile of the antitragus (the fold situated near the auditory canal) and the degree of torsion of the anthelix or interior fold are all things of which the existence must be known in order that the detective may think to observe them. It is all these little features, taken as a whole, that constitute the "speaking portrait" which is tending more and more to replace the simple photograph for police researches. Easy to transmit by telegraph, it embodies the characteristic features of a countenance, and these alone. The detective who knows them, without having seen the face as a whole, runs no risk of being influenced by a general resemblance; and his attention, being limited, is directed exactly where it may be of use to him.

After a few weeks of study and provided with one of these simple cards, the inspectors quickly find in the courtyard of the depot, in the midst of two hundred prisoners, the individual of whom they have a "speaking portrait" much better than if they were guided by an ordinary photograph. As a matter of fact, certain cases of recognition seem almost incredible. At the Prefecture of Police there is recorded the case of a man who was killed by being shot in the head with a gun, and in whom a woman asserted that she recognized her husband. Despite this formal testimony, the Service de Sureté, taking M. Bertillon's principles of identification as a basis, still hesitated. It required the appearance of her missing husband to convince the woman of her mistake and to confirm the opinion of the police.

Although M. Bertillon's system has been in operation but four years, it has already furnished all the detectives of the Service de Sureté with the data indispensable for the intelligent and effective prosecution of their calling. No new detective can be put in charge of a case unless he has been previously taught this special art.—For the above particulars and the engravings we are indebted to L'Illustration.

TEACHING THE CHARACTERISTIC FEATURES OF THE COUNTENANCE AT THE PREFECTURE OF POLICE, PARIS.

INTO THE HEART OF CHINA.

W. KIRKPATRICK BRICE, son of the late Senator Calvin S. Brice, has just returned from a journey through the center of China. He was a member of a survey party sent out by the syndicate formed by his father a year ago, and with it made an overland journey from Hankow, the great commercial city of the valley of the Yang-tse-Kiang, to Canton, on the southern coast. He was seventy-seven days en route, and penetrated a country which has ever been closed to the white man. His narrative of his adventures in China follows:

"We entered the country at Shanghai, and, after penetrating the interior in a westerly direction for a distance of 650 miles, turned to the south at Hankow, where our actual work began, and traveled overland down through the center of the empire to Canton, a distance of 750 miles. We regained the coast at Hong-Kong after a journey of 1,400 miles, that was interesting at every step and filled with more adventure than usually falls to the lot of the traveler who goes to the far East. China, with its vast fields of unexplored country, its densely populous interior provinces that have been locked to the explorer and trader, its countless millions of people, its present political importance as the contention of Europe, which has learned its marvelous commercial opportunities, its peculiar civilization that stopped centuries ago, and its strange people, holds a fascination for the investigator, and I prized the chance that came to me to see it.

"Our party was headed by Mr. William Barclay Parsons, well known in connection with the Rapid Transit Commission of New York, and included R. C. Hunt, a civil engineer; E. C. Coulter, of the Chesapeake and Ohio Railway; H. B. Mager, a civil engineer; Charles Denby, Jr., son of Charles Denby, of the Philippine Peace Commission and formerly United States Minister to China, who acted as our interpreter; William S. K. Wetmore, son of Senator Wetmore, of Rhode Island; Dr. Jellison, a missionary doctor of Nanking; Capt. W. W. Rich, an American connected with the Chinese Imperial Railways Department, and myself. Mr. Parsons decided to make the journey and survey in the winter, as it was thought best to avoid the extreme heat of the summer season, and also because the rivers are low during the winter. Our expedition was organized at Shanghai, and was given every possible assistance by the Chinese government. Sheng Tajen, chief of the Chinese Imperial railway service, detailed two young Chinese mandarins to accompany us, and they, with Capt. Rich, were the representatives of the government in our party. Their presence, when we penetrated the untraveled country, greatly facilitated our work. Their names were Woo and Lo, and they were both most interesting fellows. During one of China's progressive periods, Woo and Lo were selected with a number of other young men for foreign education at government expense. They were sent to the United States and educated at the Troy Polytechnic Institute. Woo resided here for fifteen years and Lo for several years. They both profited excellently by their American training; in fact, they had our point of view, and Woo still retains the slang of his American days.

"The journey up the great Yang-tse-Kiang from Shanghai to Hankow is as easy as a trip on the Mississippi, and can be accomplished with the same comfort. We traveled on steamers of American build, commanded by American officers. It is a trip that consumes four days, and my inclination was to remain on deck constantly. The river is very broad at the mouth, and the land on either side is very low-lying. Often the land cannot be seen. As is well known, the river is slow-moving and very muddy. As you ascend the river the country becomes quite abrupt, and picturesque islands, rocks, and cliffs appear. The valley is densely populated, and rice is the staple product. You are still in civilization. The telegraph is available, and the postman will receive and deliver your letters. Hankow has a fair-sized foreign population, good hotels, and good English and Russian clubs. Hankow is the center of the tea trade and the chief commercial city of the province of Hu Pei and the great central district of China as well, but the provincial capital is Wu Chang, on the southern and opposite shore of the Yang-tse.

"Hankow is situated at the junction of the Han River with the Yang-tse, thus increasing its importance as a base and distributing point, and it has been predicted that in time it will become the great commercial city of Eastern Central Asia. At Wu Chang we were received by the Viceroy Chang Shig Tung and Sheng Tajen, of the Imperial Railways Department. The viceroy is one of the noted men of China. He is a very able man, having taken first place in his year at the Pekin examinations. Being the first scholar of China is the highest intellectual honor attainable, and carries with it political credit as well. He is also said to possess the virtue, so rare among Chinese officials, of administering his affairs with absolute integrity; in other words, he doesn't 'squeeze.' He is, besides, progressive and pro-foreign. As a sample of his progressiveness, I may say that at Wu Chang he has established an agricultural college, where a staff of three American experts teaches young Chinese the most recent scientific methods of agriculture. At Han Yang he has also established a steel works on modern lines, which was installed by Europeans, but is now managed by Chinese entirely. He received us with great courtesy, and showed marked interest in the railway project. In fact, he has been one of the leading spirits in the enterprise since it was first proposed. Our interview with him was most interesting. Under the guidance of Denby we had been brushing up on etiquette, and the first ordeal came when we were presented. It is the polite thing for the viceroy to insist that you be seated first, and the polite thing for you to decline, bow, and insist that he sit down first. As a result, there is a protracted session of bowing that ends in a compromise, for finally you all take seats at the same moment.

"The aged viceroy sat at the same table with us, and began by warning us that we must go slowly through the provinces of Hu Pei and Hunan, where our course lay on the mission to Canton. He assured us, however, that we should have all the protection that he could give or influence, and I want to say that he kept his word, and that it proved amply sufficient. We talked for about an hour and a half, and said all the pleasant things that we could think of. He gave us sweets, champagne, and cigars, and, as is the usual custom, dismissed us by ceremoniously drinking our health in a cup of tea. Sheng Tajen is an extremely clever man also, and, unlike most Chinese, knows enough about foreigners to talk directly to the point. He was invaluable to us in the final preparations for the trip. We were only in Hankow a few days and were rather sorry to leave, for we had been very hospitably treated by the Chinese officials, American Consul Wilcox and the members of the English colony. Then we anticipated serious trouble in crossing the provinces of Hu Pei and Hunan. People who understood the scope of our project freely predicted that we would never carry out the plans. The country we were to penetrate, particularly the province of Hunan, had never been invaded by foreigners, and it was doubted whether the natives would permit us to intrude upon their privacy. Our route lay due south from Hankow, through three of the central states of the empire, with Canton on the southern coast for a terminus, a distance of 741 miles. Possibly the difficulties were exaggerated, as we did not encounter any very formidable obstacles. Only in one or two instances was there any show of hostility by the Chinese, and no trouble resulted then. No doubt the fact of our having an escort of soldiers minimized any danger, and the further fact that the various viceroys sent letters ahead warning the people of our approach and ordering that we be received with honor and properly treated.

"A circus in an American town never attracted half the attention that our party did in those remote districts of China. The people would gather around us in hundreds and follow us for miles, jabbering as if we were creatures from another world. I happened to be the only blond in the party, and was, indeed, a typical 'foreign devil,' the kind they have heard about in a fairy-tale sort of way, with white skin, blue eyes, light hair, red beard, and sufficient height. They have heard nothing but evil of foreigners, such as our appetite for babies, and powers akin to the evil eye, and their dislike is partly due to fear. We were constantly on the alert to discover their temper, used all the tact we possessed, and as a rule got on well with them, in spite of their prejudices against us. Fortunately, they were usually good natured and easily amused, and we always tried to get them laughing with us instead of at us. It didn't take us long to learn that there is a saving grace in humor even among these people of such a different race and civilization. The first of us got away on December 11, in an advance party under Mr. Hunt, and the rest of the expedition joined us a week later at a bend of the Yang-tse, forty miles up stream. We really worked in two parties through the trips. Our course at first was southwest, following the Yang-tse. We had two houseboats, which, to show our Americanism, we called the 'Mary Ann' and the 'Daisy.' Later our flotilla was joined by a couple of Chinese gunboats. We secured the latter for protection, and also for use in saluting officials and cities along the route.

"We made poor progress at first, principally because we did not know the country. Our plan was to rejoin the boats nightly and also to connect with a town where our soldiers, who numbered one hundred, and our coolies, who numbered fifty, could get food and shelter. Frequently, after working all day on the line, we had to walk from six to ten miles to reach the boats. The bottom lands of the Yang-tse, through which we went, are flooded in summer, and in winter are cut with a series of rivers and lakes, and it was necessary to make frequent detours to carry on the work. Then, too, we were retarded by officials who procrastinated and sought to delay us and swerve us from our purpose, but Mr. Parsons, with characteristic determination, pressed forward. Christmas day found us at Ping Shui Pu, just over the border of Hunan. We ate Christmas dinner walled in by a huge mob of ragged, dirty, jabbering coolies, whom we had to placate. The soldiers forming our escort gave us a certain amount of importance, but we had to depend upon our tact for real protection. These soldiers, by the way, were one of the oddest and most amusing features of the expedition. They were strongly reminiscent of the army in a comic opera. Their costume was brilliant with orange and green or blue and red, with a white circle of cloth stitched upon the coat in front and another behind. Characters sewn upon this white circle told the regiment the wearer belonged to. Whatever its object it would make an excellent target for an enemy's bullet, and it is significant that it faces both ways. They were armed with swords, fans, and umbrellas, sun and rain being, perhaps, their most customary, if not their most dreaded, foes. Some of them had old muskets which may have seen service in Europe in some previous incarnation, but which had certainly never been fired by their present owners, since they are not provided with any ammunition. Others carried long, two-handed swords, with rusty iron blades, while many made a warlike showing with pikes, three-pronged forks and other archaic weapons. Perhaps the bravest of all were those who depended on frightening the enemy with brilliant-colored banners. Their appearance was certainly most bellicose and formidable. They had, apparently, little idea of military discipline, though they were always on hand, and did some good service in keeping back the crowds. This they did in a most amusing way.

"Some of them carried bamboo sticks, split in such a way that when snapped quickly they made a loud, cracking noise. When they struck any one, it certainly seemed as though the victim had received a severe blow, but in reality they never hurt any one at all, and never intended to. The oddest part of it is that the people took it all seriously and acted out their part to perfection by looking hurt and keeping out of the way. It all seemed like a children's game. Yet, without this absurd mockery of protective power we might have had some serious trouble. On the afternoon of December 25, Mr. Parsons pressed ahead and discovered a pass through the mountains down into the valley of the Siang River, which he called Christmas Pass in honor of the day. The Chinese officers called that night and sought to prevent us from going into the Siang Valley. They told us of clan fights on our intended route, and declared that they could not be responsible for our safety. We went ahead the next day, however, and were not molested. A few days later Mr. Parsons, Capt. Rich, Woo, and myself left the party and went west to the city of Yo Chou, which is situated at the junction of the Yang-tse and Siang Rivers. It is a walled city of two hundred thousand population, has telegraphic communication with Hankow, and is to be shortly opened as a treaty port. They were holding the annual examinations there, and ten thousand students had come to the city to take part, and on that account we were forbidden to enter the city. Woo was allowed to enter, however, and the rest of us remained on our boats.

"The overflow from the Yang-tse, Siang, Yuan and half a dozen other streams forms an immense lake west of Yo Chou. It is over a hundred miles long during the freshets, and only a great mud sink during the winter. Yo Chou promises to be quite a trade center, for it already has good shops, and the tea country in the higher levels back of it makes it important to that industry. We went up the Siang River, and a week later rejoined the other members of the expedition at Siang Yin, to which point they had carried the survey. Here we were hospitably received by the Shen magistrate and by a Chinese gentleman in the telegraph service, Yu by name, who had been to the Tien-tsin University, and who spoke English very well. We were entertained at a dinner which was entirely Chinese, and greatly enjoyed the novelty of some of the dishes as well as the amusement created by our somewhat ludicrous attempts to manipulate our chopsticks. The menu included, besides some more familiar courses, shark fins, pigeon eggs, wood fungus, lotus seeds, snail mussels, and bamboo shoots. The dinner was well cooked, and we were rather surprised to find how good it was. Our visits to cities continued to attract general attention. The trumpeters with our soldiers would enter first, blowing as if their lives depended upon it, and every blast brought hordes of Chinese.

"At Tung Kuan we had our first serious trouble. Some of the ill-natured ones in the big crowd began to show their contempt for us by hooting and throwing stones. The officials and soldiers surrounded us and hurried us to our boats, where we were out of harm's way. During the confusion Mr. Parsons was struck by a stone, but was not hurt. The Siang is a very large river with fairly swift current and is navigable for fairly large steamboats probably as far as Heng Chou. It has for the most part high banks and in some places very picturesque cliffs. The country is generally hilly and the main valley is of varying width. We made anywhere from ten to sixteen miles a day up the Siang and were not seriously retarded. We reached Chang Sha, capital of the province of Hunan, on January 7, and were reluctantly received by the governor. It seems that his predecessor had been dismissed from office for being progressive, and I guess that he feared that a precedent had been established. He seemed also to think that if he showed us any consideration, there would be a great popular demonstration in which he would be unable to carry out his orders to protect us. He finally decided to give us a reception, and the nature of the concession will be understood when it is stated that we were the first foreigners who ever entered his yamen. He said that his people were not yet ready for a railway, and that they would have to be educated before one could be built. Chang Sha is a large and important city with an estimated population of six hundred thousand, including a city of boats, with regular streets and blocks, which covers much of the river. There are some fine-looking temples and houses, and the whole city is surrounded by a massive well-built wall and moat. The city is well situated, and back of it are some hills which afford beautiful views of the river and opposite mountains and valleys. In the days of this governor's predecessor the place was very progressive, and an electric light plant was started. Unfortunately, the administration and policy were changed, and I believe reform is now dangerous.

"Opposite Heng Chou, another large city, we encounter the Lei River, which flows into the Siang after draining a large area to the southeast. Here we left the Siang, continuing up the east bank of the Lei. We were surprised one night to receive a call from a Chinese Christian missionary, a member of the London Inland Mission. Hunan is not an agreeable place for missionaries; there are very few stations in the entire province, and they are compelled to keep very quiet. This fellow seemed much encouraged with his mission at Heng Chou, and perhaps we were wrong to doubt his sincerity; we at least hoped we were. We were a little sorry to leave the Siang, which is one of the most beautiful rivers I have ever seen; but the Lei is also abundant with magnificent scenery; and, indeed, the country itself, as it became more mountainous, delighted us more and more. In places it is rugged and wild, but there will be no difficult engineering problem to face in building the railway through the country. In fact, when the road is finished, this will be one of the places where palace car passengers will be tempted to keep their noses flattened against the window pane in order to miss nothing as the train speeds through this picturesque part of the province. That is one of the things I thought of as we trudged slowly our ten to sixteen miles a day. There are immense coal deposits in this vicinity, and we passed several coal towns and examined many specimens. It seems to be an excellent coal, but, owing to lack of transportation, has never had a market. Beyond the city of Yung-Hsing we abandoned our boats and started across country that daily grew rougher.

"Five hundred miles from Hankow we made the Che Ling Pass, which is in the mountains that divide the provinces of Hunan and Kwang-Tung, and is the ancient trade route of Central China. It is approached by an old stone highway that greatly interested us, and is in the center of a rather wild, mountainous district. Over this highway wound a continuous string of pack mules and coolies carrying merchandise. We were elated to reach and pass Che Ling, for ever since leaving Hankow it had been a sort of goal for us, and the rest of the journey seemed comparatively easy. Our descent from the mountains was along the branch of the Pei River, and it was in many respects one of the most interesting parts of our trip. The river winds through a series of wild gorges, and the country is simply beautiful. We were not sorry to leave the hermit province of Hunan, and rejoiced to enter Kwang-Tung, where the whole character of the people and country seemed to change. The people of the latter are accustomed to the sight of foreigners and were less curious about our presence and movements. The buildings are better and the tradespeople show more activity and are brighter. We also saw more foreign goods offered for sale in the shops and stalls. We secured large boats again at Ping Sze and kept them until we reached Canton, 220 miles distant. I am not overfond of Canton, but its looming pagodas and pawnshops looked welcome when we got the first glimpse of them. We had been seventy-seven days on the journey, and had walked 750 miles.

"The railway will be of immense commercial importance, for it will open up the provinces of Hu Pei, Hunan, and Kwang-Tung, three of the most important in the entire empire. It will connect at Hankow with the Belgian line that is to run to Pekin, and there join the Russian line that is projected to that city. It will have a connection with the sea at Hong-Kong, and as it crosses the great inland waterways of China, will have an immense influence in the opening and development of the country. It is part of the great international system that is to give the country transportation. The 'open door' and the preservation of the integrity of China are of the highest importance to us, for we have a splendid opportunity to profit by the development of the country. This seems to me to be of special importance to our Western States, for, owing to their geographical position, they have a wonderful advantage in tapping the commerce of this marvelous Oriental empire."—New York Sun.

THE ELEPHANT AND HIS ANCESTORS.

By W. VON REICHENAU.

THE elephant is indisputably one of the most remarkable mammals which has ever lived on this earth. When for the first time we are confronted with such a colossus, we are most profoundly impressed. Not the size alone—many specimens attain a height of twelve feet—produces this astonishment, I might say, this stupefaction; but the peculiar appearance, the queer movements, also contribute their share to the surprise

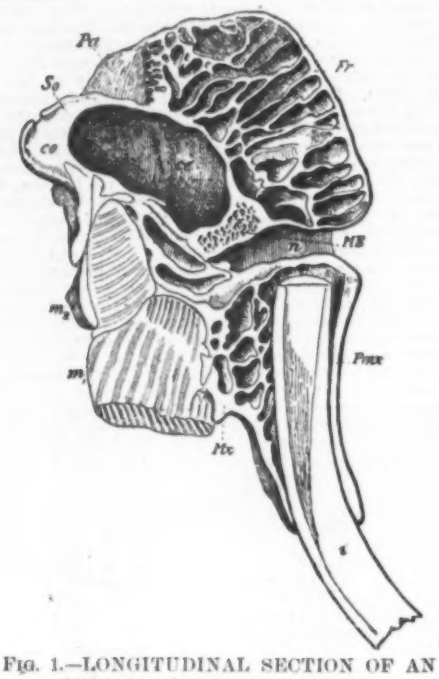


FIG. 1.—LONGITUDINAL SECTION OF AN INDIAN ELEPHANT'S SKULL.

So, occipital bone; *co*, condyle; *Pa*, parietal bone; *Fr*, frontal bone; *Mx*, maxillary; *Pmx*, intermaxillary bone; *ME*, mesethmoid; *cr*, brain-cavity; *n*, nasal cavity; *i*, incisor; m_1, m_2, first and second molars.

which we feel. First of all must be mentioned the strange, monstrous head, which, carried by an exceedingly short neck, whose flat vertebræ prevent all side movement, looks as if nothing could withstand it. The unusually broad forehead tapers at the bottom into a six-foot trunk, giving the face the appearance of an acute-angled triangle.

A more tireless, busy servant than this trunk cannot be imagined. Here it sniffs about—for it is a nose which has developed into an organ of prehension—seeking for food; there it collects sand and dust, and blows them on the enormous body either for the purpose of warding off flies or merely for sheer amusement. This trunk, huge as a giant snake, fills itself with water, which is either discharged into the mouth to quench thirst, or sprayed in a shower over the head and body. Many, indeed, are the duties of this trunk. It must break off branches, uproot young trees, carry beams, gently lift up human beings from the ground, find needles in haystacks, or strike blows which would fell the strongest buffalo.

Most peculiar, too, are the prominent, ever-rolling eyes, placed, as they are, toward each side of the head. To many their expression appears reflective, spiritual; but to me they always seem dull. Owing to their great mobility, they do not leave an impression of collectedness or of thought. But it does not, therefore, follow that the elephant is devoid of all intellectual adaptability. To my mind he is the only animal that can be immediately transformed from a savage brute into a docile, domestic beast.

In front of the eyes, at each side of the trunk, there grow from the upper jaw two cylindrical incisors, which describe an arc of small curvature. From time immemorial these teeth have supplied us with ivory.

FIG. 2.—SKULL AND LOWER JAW OF *DINOTHERIUM GIGANTEUM, KAUP.*

One fifteenth natural size. From the Lower Pliocene sands of Eppelsheim in Hesse. The skull has been lost; the lower jaw is in the Darmstadt Museum.

On the exterior they are longitudinally furrowed, and in color vary from white to coffee brown. Within the jaw they have a pulp-cavity; while at the outer ends they are solid. The ivory of which these incisors are composed is a dentin of great hardness, toughness, and elasticity, due to the fineness and regularity of the dentinal tubules, which radiate from the axial pulp-cavity to the periphery of the tooth. Besides fine, angular, radiating lines, the tusk, on cross-section, shows a series of contour-lines, concentric with the axis of the tooth, arranged about a central, raised spot, which represents the calcified pulp. The appearance of these contour-lines is due to the regular arrangement of minute spaces called interglobular.

A pair of flapping ears completes the exterior of the

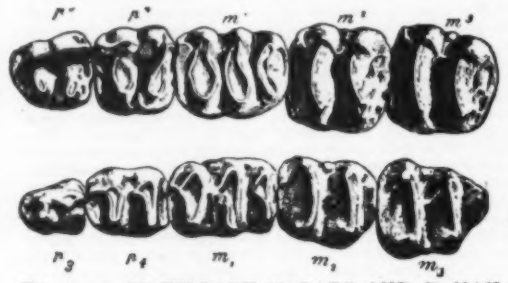


FIG. 3.—A, MAXILLARY MOLARS, AND B, MANDIBLE MOLARS OF *DINOTHERIUM BAVARICUM, MEYER*

elephant's head. In the Indian species the ears are very movable and properly proportioned; but in the African elephant, on the other hand, they are unproportionately large, resemble fire-screens, and lie as if glued to the neck.

The spinal column of the elephant is convex instead of concave, as in a horse or rhinoceros. The legs, like pillars they seem to me, are all similarly formed, and have each five toes, with hoof-like nails—a very primitive arrangement.

Although the elephant can be considered an ungulate (hoofed animal), he nevertheless presents such remarkable differences in the structure of the skull, that naturalists have given him an isolated position in the animal kingdom. Upon the skull, as shown in Fig. 1, many prominent bones may be seen. The interior has numerous passages separated by partitions; the nasal bones are short, and the nostrils form an upwardly leading duct. Compared with the size of the skull, the brain, although the largest of all mammalian brains, is exceedingly small, and is strongly developed in its convolutions. As in the gnawers, the teeth are composed only of incisors and molars.

For our modern elephants was created the sub-class of *Proboscidea*, belonging to the pachyderm ungulates. The class comprises only the two varieties previously mentioned. The elephant, therefore, stands alone in the animal world, a paradox in the natural systems based upon consanguinity or upon descent, a broken branch of a burnt tree, the last witness of a mythical, primeval world (Vorwelt). If, among our present animals, there is no way of bridging the chasm which separates the elephant from other animals, we must seek in the prehistory of the world an answer to this riddle.

The first traces of pachyderms in any way related to the elephant are found in the Miocene period. At that time the climate of Germany was mild. Lakes surrounded by evergreen forests, under whose protection there still flourished several species of palms, dotted the country here and there. The flora and fauna of that time teach us, so far as they can be compared with those of modern times, that the climatic conditions were those of southern Japan, or of the Mediterranean countries. In other words, there was no winter; the climate was subtropical. Together with the tapir, still found in Central and South America and in Southern India, the Dinotherium roamed the

FIG. 5.—*MASTODON ARVERNENSIS CROIZ. JOB.*

Top view of right lower jaw. One-tenth natural size. From the Pliocene beds of Asti.

German forests. Piece by piece the bones of this proboscidean have all been gathered. We now know that he was an animal fourteen feet in height, that he had a trunk and long column-like legs. The long skull (Fig. 2) of this animal has no upper jaw incisors, is only moderately high and has a broad frontal bone. Most peculiar is the formation of the lower jaw, the forward portion of which is elongated. The strongly developed symphysis (front portion of the jaw) is bent downwardly at right angles and carries a pair of strong backwardly-bent incisors. These tusks of the Dinotherium describe a curve similar to that of the tusks in the upper jaw of the walrus. The tusk, on cross-section, shows a dense, concentric, radiating mass of ivory which is not waved (*guilloché*). The outer surface is sometimes circular, sometimes oval, the latter formation occurring more commonly in the weaker female animals. The lower jaw of the Dinotherium is unique among all mammalian jaws; for even the similarity with that of the *Sirenia* is only remote and quite superficial. It constitutes an especial differentiation of species. The molars are five in number in both upper and lower jaws, there being two premolars and three true molars, as in man. So strong is the resemblance between the molars of the Dinotherium and the tapir, that Cuvier was led to conclude that the first discovered remains of a Dinotherium were those of a tapir. The first molar or grinder has three ridges, the others two; the last molar is also formed with a small talon. When young the teeth are exquisitely pearled; but when mature are sharpened and divided by deep hollows, owing to the wearing

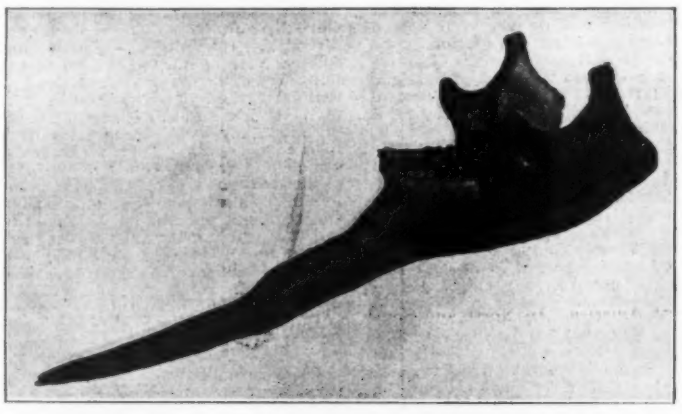


FIG. 4.—LOWER JAW OF A MATURE *MASTODON LONGIROSTRIS, KAUP*, FROM THE LOWER PLIOCENE STRATA OF HESSE.

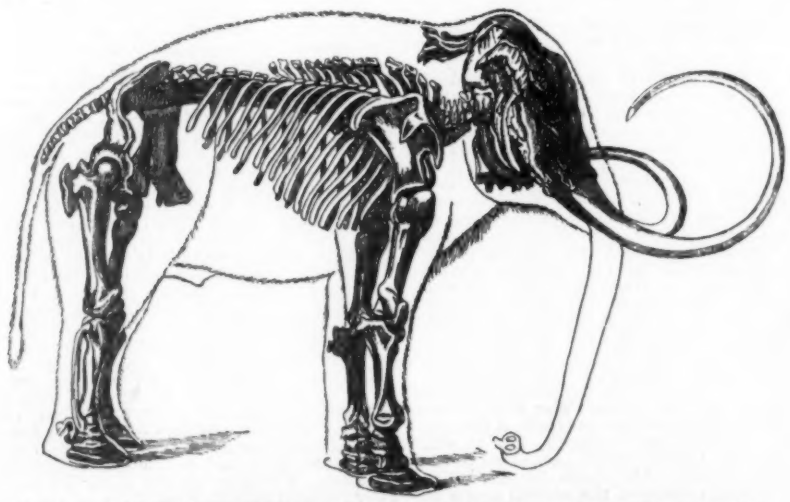


FIG. 6.—*ELEPHAS PRIMIGENIUS BLUMENBACH*—SKELETON IN THE MUSEUM OF ST. PETERSBURG.

away of the cement. The teeth are shed in the manner common to most ungulates.

The species is found in the middle Miocene strata of Central and Southern Europe, and in the upper Miocene to the lower Pliocene in the same regions. In the upper Miocene of Southern Asia (Siwalik-layers of Eastern India) they are also met with. The predecessors of the genus which disappears in the lower Pliocene and which has no species (Weinsheimer even claims to

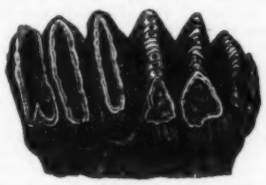


FIG. 7.—FIRST UPPER MOLAR OF *STEGODON CLIFTI, FALCONER AND CAUTLEY.*

Upper Pliocene or lower Pleistocene of Burma. One-quarter natural size.

have united the little known forms into one species) have not as yet been discovered.

In the mastodon the formation of the head was more elephant-like. The body was longer and heavier than that of the elephant, and the bones were thicker. The cervical vertebræ were not so short; and the neck was, therefore, longer and more mobile.

During the middle Miocene, mastodons inhabited Central Southern Europe and North Africa; and during the upper Miocene also Southern and Eastern Asia. The habitat remained the same for the entire Pliocene period, with which they disappeared. In North America we first find them in the upper Miocene (Deep River or Tieholeptus strata of Montana), becoming more widely distributed in the lower Pliocene (Loup Fork strata), and in the beginning of the upper Pliocene

FIG. 8.—A, MAXILLARY MOLAR OF AFRICAN ELEPHANT; B, MAXILLARY MOLAR OF MAMMOTH (*ELEPHAS PRIMIGENIUS*) VIEWED FROM BELOW.

conquering also South America. In North and South America they are found even down to the Pleistocene period, but disappear for some inexplicable cause with the first appearance of man. The geologically older forms of the genus *Mastodon* have, besides a pair of huge auxiliary canines or tusks, a similar pair somewhat less markedly developed in the mandible. The mandible tusks are, however, not downwardly bent as in the Dinotherium, but project forward with a slight upward curve. The mastodon molars resemble those of such suilline animals as the hippopotamus. But it must here be mentioned that in the later forms or species of the genus in question, the structure of the molar approaches more and more that of the elephant grinder, until in the genus *Stegodon* a complete transitional form is developed. Simultaneously, or even before the transformation of the suilline into elephant molars, there occurs an arresting of the mandible tusk, a shedding in youth, and finally a retrogression or abbreviation of the once marked symphysis. In place of the tusk-bearing symphysis there finally remains only a short chin-like stump (rudiment), which is still present in our modern elephants.

Of the older European mastodon species, *Mastodon angustidens, Cuvier*, became the best known. A restored skeleton of this animal is to be found in the museum at Paris. The waved (*guilloché*) ivory mass composing the upper tusks retains a broad band of enamel which in the lower tusk has almost disappeared. The last molars but one have only three ridges (subspecies *Trilophodon, Falconer*). In *Mastodon* (*Trilophodon*) *turicensis, Cuv.*, the same teeth are provided with low intermediate ridges. The last molar has an additional ridge in both species. The slender, long symphysis of the lower jaw in *M. turicensis* bears only small tusks. The former species has been found less often; but both occur in Southern Germany, Switzerland, France, Spain, Syria, Bohemia, and Hungary; and the last-mentioned species in Southern Russia. These animals are not much taller but considerably longer than our elephants. One ridge more is found in the molars of the *Mastodon longirostris, Kaup* (subspecies *Tetralophodon*). A very complete lower jaw of this species was found a year ago not far from Alzey, in the Rhine region of Hesse, in the lower Pliocene, "Dinothere Sands," together with teeth of *Hipparion*, and under my direction were excavated with considerable difficulty. Measured from the rearmost condyle diagonally to the top of the tusk, the length of this lower jaw (Fig. 4) is two meters (6·56 feet). The tusks project 73 centimeters (28·689 inches) from the 55 centimeter (21·615 inches) long symphysis and extend into the latter with their fangs to a point beneath the third ridge of the last molar, and hence have an entire length of 153 centimeters (50·129 inches). The tusks have no enamel and are composed of black-brown, waved (*guilloché*) ivory. The jaw has altogether four molars. The first two are considerably worn away; while, on the other hand, the last two have their rear ridges still intact. The first molar has the typical ridges and the shape of a rectangle 14 centimeters (5·502 inches) by 7·5 centimeters (2·947 inches). The last tooth has five ridges and a three-cusped talon, and, measured on the crown, is 22 centimeters (8·646 inches) long and 9 centimeters (3·537 inches) wide. The enamel of these teeth is 0·8 centimeter (0·3144 inch) thick, steel blue in color on the exterior, and extraordinarily dense. Indeed, the mastodons have the most compact enamel of all mammals and were on that account good masticators. The food of the genus undoubtedly consisted of plants, reeds, and twigs of trees. In the lower jaw of the Mayence species, the elevated position of the premolars is particularly noticeable, due to the tusk-pulp's extending beneath their roots. The stronger the development of this pulp, the higher will be the position of these roots. The maxillary tusks of *Mastodon longirostris* develop similarly to those of our elephants. When the animal is young, the pulp or tooth cavity extends to the very tip; but when older, the entire tooth down to the root becomes solid. It is interesting to note here that in *Mastodon longirostris*, the young tusks bear a broad band of enamel, which later disappears. Young tusks of this species are not to be distinguished from those of *Mastodon angustidens*.

The later, upper Pliocene mastodons, when mature, no longer have mandible tusks, the alveoli after the milk-tusks have disappeared soon growing together. To this younger group belongs *M.* (*Tetralophodon*) *arvernensis*. The molars in this species are also found—but very rarely—in the upper Pliocene formation of the Mayence basin, and are characterized by the alternating cusps of each half ridge. Better known and generally recognized as typical is the Ohio species, called by the Indians "Father of Oxen," *Mastodon* (*trilophodon*) *americanus, ohioticus giganteus.*

Of this species the most complete skeletons have

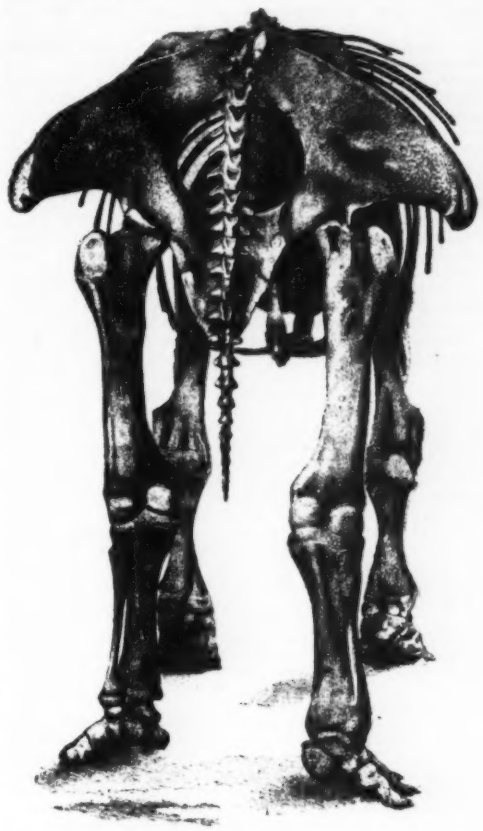


FIG. 10.—POSTERIOR VIEW OF MASTODON.

been obtained from the banks of the Hudson; but large quantities of bones are found accompanied by remains of *Elephas* and *Megalonyx* (an extinct sloth of the size of an ox) in the diluvial, black, salty, boggy soil of Big Bone Lick, Kentucky. Young animals have also two short, straight, mandible tusks, which, however, early fall out, whereupon the alveoli close. The skeletons found in Newburg and Cohoes, N. Y., have a height of shoulder of 9·84 feet to 10·824 feet. The bones are very massive, and the vertebræ long. In this species the upper tusks have a decided upper curve.

Why do the mandible tusks disappear in the tertiary? It is evident that the *Proboscidea* are descended from thick-skinned animals that used their enormous upper and lower jaw incisors in seeking food. Later the

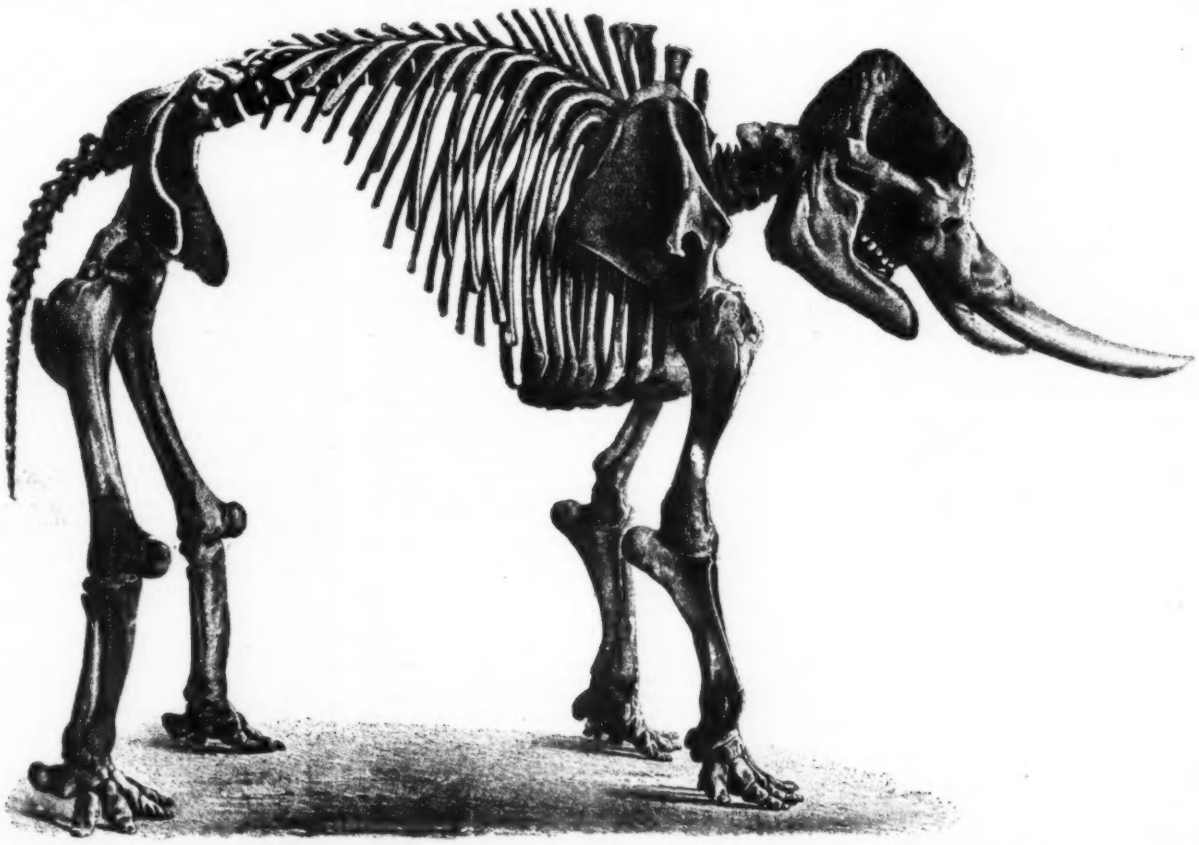


FIG. 9.—SKELETON OF MASTODON FOUND IN A POT-HOLE NEAR COHOES, N. Y.

trunk, originally very short, developed into the only organ of prehension; and the incisors were no longer used. But as in the gnawers they had the property of perennial growth. As the tooth wore away, new substance would grow to take the place of that which had disappeared, the growth keeping pace with the deterioration. But as soon as the tooth was no longer subject to this deterioration, free growth in a longitudinal direction began; and the incisors became, therefore, rod-like tusks. That the tusks must have been a later development is evident from the fact that they could not serve as organs of prehension.

A transitional form between the later mastodons and the elephant is found in the genus *Stegodon*. The lower incisors are lacking, and the upper are enormously developed, without, however, having a band of enamel. The molars (Fig. 7) consist of six to twelve low, roof-like, convex, transverse ridges, the valleys of which are usually filled with cement. As they are worn away, the valleys in the three forward ridges, as shown in Fig. 7, become hollows of enamel filled with dentin.

The genus *Stegodon* had four species, and flourished from the Pliocene to the Pleistocene in Southern India and Eastern Asia. *Stegodon clifti* approaches most nearly the mastodons; but the molars have, besides a little cement, two or three ridges more. In *St. bombifrons, F. and C.* (India and China), the valleys between the ridges are completely filled with cement.

Another transitional form between the mastodon and stegodon is found in *Elephas planifrons, F. and C.*, with the premolars still present, which in some stegodons seem to be lacking. The skeleton structure of *Elephas* is similar to that of *Stegodon*. The skull has a higher arch; and the symphysis of the lower jaw is short and thick. With the exception of *E. planifrons*, the species has no premolars. Before the permanent tusks have been developed the intermaxillary bone bears two milk-incisors, thinly coated with enamel. That in this phenomenon a repetition of the ancestral form is to be seen, is self-evident. The grinders comprise from five to twenty-seven high ridges pressed together in a rearward direction, and notched at the upper edge. The intermediate valleys are completely filled with cement, which covers even the exterior surface of the crown. As the teeth wear away from constant mastication, they assume that peculiar form so characteristic in old animals, which has erroneously caused the worn molars of *Elephas antiquus, Falconer*, to be attributed to *E. priscus*, the direct ancestor of the African elephant.

The manner in which the molars are shed in the genus *Mastodon* shows a transition to the genus *Elephas*, in which the original relations have remained constant. In *Mastodon angustidens, longirostris, arvernensis, latidens, Pandionis*, etc., the two rear milk teeth are first supplanted by premolars; while in *M. americanus Falconeri, sivalensis, audium*, no substitutes for the milk teeth are provided. The last premolar in the former class is thrust out before the appearance of the last grinder, so that, in opposition to the dentition of the Dinotherium and approaching the dental structure of the elephant, never more than three molars on each side are simultaneously in use (in *Elephas*, two). The foremost grinder drops out upon the appearance of the last molar (wisdom tooth), so that in each half of the jaw two molars are added. When the animal is very old, the last molar forces out the preceding grinder and remains alone in the jaw, as shown in Fig. 5.

The molars are shed as in our modern elephants. In the latter the development of the molars requires a long time. In the Indian elephant, for example, the last molar begins its duties only in the fifteenth year, and drops out between the twentieth and twenty-fifth. The second molar appears in the twentieth year; the last correspondingly later, as in man. The substitute teeth of elephants do not, as in other ungulates and proboscideans, lie under those in use, but behind them in large alveoli. They appear with their front portions first, and gradually thrust out the preceding tooth, which has been already quite worn away. Years ago I witnessed such a shedding of teeth in the menagerie of Weida. By resorption of the roots and by the constant pressure of the forwardly-moving substitute tooth, the first molar in the right upper jaw of an Indian elephant had been loosened. The flesh about the tooth became inflamed, and the animal, evidently finding the old tooth disagreeable, sharply jerked it out with its trunk. The operation, to be sure, was executed with true elephant clumsiness, for a fair sized piece of inflamed flesh still clung to the fangs. This piece of dental surgery was exceedingly instructive to me, and led me to infer that elephants were their own dentists.

We have seen the ridges of the molars increased from 1-3 in the Dinotherium to 2-5 in the mastodon, and even to 6-12 in the stegodon; we have observed the increase in the ridges of the *Proboscidea;* and now we shall glance at the number of ridges in the molars of the upper and lower jaws of the more modern elephants, basing our tabulations on Zittel.

	Molar 1.	Molar 2.	Molar 3.
1. *Elephas planifrons*	7	8	10
	7	8-9	10-11
2. " *africanus*	7	8	10
	7	8-9	11
3. " *meridionalis*	8-9	8-11	10-14
	8-9	9-11	11-14
4. " *antiquus*	9-12	12-13	15-20
	10-12	12-13	16-21
5. " *primigenius*	9-15	14-16	18-27
	9-15	14-16	18-27
6. " *indicus*	12-14	16-18	24
	12-14	16-18	24-27

Among the fossil elephants *E. planifrons* and *meridionalis* resemble the African type; *E. antiquus* and *primigenius* (the mammoth), the Indian form. Like *E. primigenius*, *E. meridionalis* attained a height of four meters (13·12 feet); but *E. antiquus* was sometimes more than five meters (16·40 feet) in height, and therefore the largest mammal that ever trod the earth.

The food of *E. meridionalis* and *antiquus* was chiefly foliage; that of the Siberian mammoth (*E. primigenius*) pine needles, which are sometimes found in the teeth of the frozen animal. Here it should be mentioned that the tusks of the great mammoths found in the middle Rhine region have neither the pronounced curve nor the length of the tusks of the Siberian mammoth.

Elephas africanus is distinguished particularly by broad, round, yet few cross ridges (Fig. 8 A). Opposed to this formation are the teeth of *E. primigenius* (Fig. 8 B) and *indicus*, with closely set, quite shallow enameled valleys.

The elephant evidently at some time migrated from his primeval southern Asiatic home and spread over Asia Minor and Europe to Africa on the one side and over Northern Asia to North and South America on the other side. At the present time the last species inhabit Southern Asia and tropical regions of Africa, whither they migrated at a comparatively late period.

We are indebted to Prometheus for our particulars and for some of our illustrations.

THE "WOURALI" POISON AND ITS USES.

By Dr. EUGENE MURRAY-AARON.

SINCE the days when that intrepid Amazon, Madam Merian, first called attention to "a poison of great potency, in use by the natives of inner Guiana," speculation as to the exact nature and source of this poison, as well as that of its antidote, used by certain of those natives with wonderful skill, has been a characteristic of the writings of nearly every naturalist or explorer who has visited the upper Orinoco or north Amazonian watersheds. Yet, to this day, but little more is known of the subject than in the day when Waterton,* who first brought the substance to Europe, wrote so charmingly of his travels in upper Guiana, sixty-odd years ago.

From the head waters of the Madeira in Bolivia and the Marañon in Peru, to the south, through the whole upper Amazonian watershed, to the mouths of the Orinoco and Essiquibo on the north, the Indian hunters have used a much valued arrow and spear poison, of one general character, from before the advent of the first European explorer. This substance, known variously as "Wourali" or "Woorali" (Guiana), "Woorari" or "Woorara" (upper Orinoco), "Urari" (Rio Negro) and "Curare" (Amazonas), differs somewhat in the superficial appearance, because of the varying crudities of the native manufacture; but its principal, perhaps only important, toxic quality is derived from the crystallizable alkaloid, Curarine, which after many ineffectual attempts on the part of Heintz, Boussingault, Roulin, Bernard, and others, the latter succeeded in isolating and in proving to be possessed in common by all varieties of Wourali.

Prof. Planchon has divided the varieties of Wourali into four principal kinds.† These are: (1) That from the upper Amazon, of which Strychnos castelnaeana and possibly S. yapurensis are the principal vegetable sources. This is the form known to Bates and Darwin. (2) That from the upper Orinoco, the Cassiquiari and Negro Rivers, derived from S. gubleri; this is the sort alluded to by Von Humboldt. (3) From British Guiana and midland Venezuela, derived from S. toxifera, S. schomburgkii, and S. cogens; the sort known to Madam Merian and to Waterton, and undoubtedly the most potent of the list. And (4) that from French Guiana, depending mainly on Strychnos crevauxi for its powers.

While this classification is now known to be somewhat fanciful, rather more botanical and geographic than toxic in its basis, it is the fact, nevertheless, that the Wouralis from the center regions selected for Planchon's classification show marked peculiarities in color, methods of incasing, etc., which make the types of each class easy of distinguishment. But, as with the natives themselves, so with the forms of Wourali; the borderlands where these regions join produce varieties that are true "connecting links," and one may obtain a series of specimens of the crude poison that shows it to be well nigh impossible to strictly maintain such a classification.

Dr. Horatio C. Wood‡ has offered a classification based on the supposition that the Wourali of the upper Amazon (the No. 1 of Planchon) may be distinguished from that of the Orinoco (Planchon's No. 2) by the latter being "full of ants, evidently put in while the poison was liquid." The fact that pounded or bruised ants are used in all of the preparations, sometimes being put in entire and at others only the expressed juices being used, this apparently depending on the whim or the laziness of the native manufacturer, all possible varieties in this respect coming from all the known geographical sources of the poison, shows this to be a rather hasty generalization on the part of that usually careful student.

There is little to be added to Waterton's quaint and graphic description of the manner in which the Indian of inner British Guiana manufactures Wourali. It is in this region where still the most potent arrow poison is produced. Says Waterton:

"A day or two before the Macoushi Indian prepares his poison, he goes into the forest in quest of the ingredients. A vine grows in these wilds which is called "Wourali." It is from this that the poison takes its name and it is the principal ingredient. When he has procured enough of this, he digs up a root of a very bitter taste and then looks about for two kinds of bulbous plants, which contain a green and glutinous juice. Lastly he ranges up and down till he finds two species of ants. One of them is very large and black and so venomous that its sting produces a fever; it is most commonly to be met with on the ground. The other is a little red ant, which stings like a nettle and generally has its nest under the leaf of a shrub. After obtaining these, he has no more need to range the forest.

"A quantity of the strongest Indian [Cayenne] pepper is used; but this he has already planted round his hut. The pounded fangs of the Labarri snake and those of the Counaconchi are likewise added. These he commonly has in store; for when he kills a snake, he generally extracts the fangs and keeps them by him.

"Having thus found the necessary ingredients, he scrapes the Wourali vine and bitter root into thin shavings and puts them into a kind of colander made of leaves; this he holds over an earthen pot and pours water on the shavings; the liquor which comes through has the appearance of coffee. When a sufficient quantity has been procured, the shavings are thrown aside. He then bruises the bulbous stalks and squeezes a proportionate quantity of their juice through his hands into a pot. Lastly the snakes' fangs, ants, and pepper are bruised and thrown into it. It is then placed on a slow fire, and as it boils more of the juice of the Wourali is added, according as it may be found necessary, and the scum is taken off with a leaf; it remains on the fire until reduced to a thick sirup of a deep brown color. It is poured into a calabash or little pot of Indian manufacture, which is carefully covered and thereafter kept in the most dry part of the hut.

"The act of preparing the poison is not considered a common one; the savage may shape his bow, fasten the barb on the point of his arrow, and make his other implements of destruction, either lying down in his hammock or in the midst of his family; but, if he has to prepare the Wourali poison, many precautions are supposed to be necessary.

"The women and young girls are not allowed to be present, lest the Yabahou, or evil spirit, should do them harm. The shed under which it has been boiled is pronounced polluted and abandoned ever after. He who makes the poison must eat nothing that morning and must continue fasting as long as the operation lasts. The operator must take particular care not to expose himself to the vapor which arises from it while on the fire. Though this and other precautions are taken, such as frequently washing the face and hands, still the Indians think that it affects the health; and the operator either is or, what is more probable, supposes himself to be sick for some days after."

It is certain from the foregoing description that Waterton was not taken fully into the confidence of those natives who initiated him into the mysteries of Wourali making. The description of the principal ingredient being the shavings from an unnamed vine, proves that they did not disclose to him the necessary use of some plant of the genus Strychnos, which must have been well known to so good a botanist. I say necessary use tentatively, however, as it is far from certain whether, without the use of any member of that genus, the added ant poisons and snake poisons would not be quite sufficient for all ordinary death-dealing purposes, even if not as quickly fatal.

The recent researches which have found "animal strychnine" to be the basis of even the mosquito's virus, and the great class of venoms, from that of the dreaded Crotalus adamanteus, the diamond-backed rattlesnake, down to that of the gnat, to belong to but one species in the toxic classification, show that unconsciously the savage has been getting his poison supply from a needlessly large range of sources, while obtaining practically but one life-destroying factor.

The Tecuma Indians, according to Dr. Jobert, use also Cocculus toxiferus and "taya," a species of arum, found to be very poisonous by him. Prof. Kobert states that in the Rio Negro and upper Orinoco districts "guachamaca," Malonetia nitida, enters largely into the Wourali there made. The United States Dispensatory states that guachamacine, isolated by Schiffer in 1883, is closely allied to, if not identical with, curarine.

The arrow poisons brought from the United States of Colombia by Dr. W. S. W. Kuschenberger, and studied by Drs. W. A. Hammond and S. Weir Mitchell,* were probably forms of Wourali, possibly of Planchon's class No. 3. I have procured very typical Wourali from the Cauca River, a tributary of the Magdalena, in Colombia.

The United States Dispensatory describes the crude Wourali of commerce as a "blackish extract, brittle, somewhat resinoid in appearance, encrusting the sides of gourds or little rude earthenware jars, into which it has almost certainly been poured in a liquid state." The method of its manufacture, as above described by Waterton, accounts for the pouring in liquid state. A very considerable collection of specimens of Wourali, made by myself, from Bolivia, Peru, Ecuador, Colombia, Brazil, Surinam, Cayenne, and Demerara, shows the color of Wourali to differ from a light bister to an almost inky black, and the consistency to run from the brittleness of glass to the flexibility of crude rubber. I have been informed by Herr A. Heinricks, formerly resident on the Teffe, a southern tributary of the Amazons, that rubber is added to Wourali by some natives, to give it greater durability and render its cracking from the arrowheads less likely.

At the Intercolonial Exposition, held at Kingston, Jamaica, West Indies, in early 1891, I had the good fortune to become well acquainted with an unusually intelligent half-breed, from the headwaters of the Essiquibo, in Demerara, who claimed to be an adept in the manufacture of Wourali. He assured me that the addition of the bitter roots, the arum, snakes' fangs, pounded ants, red pepper, etc., was of no more importance to the mixture than were the incantations and other weird antics of the native when making it. As a proof of what he said, he made Wourali for me, from a small amount of the shredded shavings of Strychnos toxifera, procured from the Botanical Gardens, through the kindness of the assistant island botanist, which, on experimentation, I found to have a perfectly satisfactory effect on barbs used to kill the introduced mongoose, Herpestes ichneumon.

This Demerara native also assured me, of his knowledge, that in the interior of all the Guianas and in Venezuela there were undoubtedly those to be found, here and there, who knew the secret of an antidote to the Wourali. Discussing this with the natives, Waterton had come to the conclusion that there was no foundation for the story that such an antidote existed, to which Von Humboldt had first given currency. Bates on the Amazons had assured himself of its existence, as have several minor travelers. On the Orinoco I had undisputed proof that this much prized secret existed, and was the source of great power and of a

* Charles Waterton, Wanderings in South America. London, 1838.

† Pharmaceutical Journal and Transactions, London, vol. 11, p. 491.

‡ United States Dispensatory, Philadelphia, 1894.

* American Journal of the Medical Sciences, July, 1850.

large income, comparatively speaking, in the hands of a few. Its selling price appeared to be as quite ten to one, compared with Wourali as furnishing the unit of value.

And there I made a most interesting discovery with regard to the capture of certain monkeys in the interior uplands. The Indian hunter of all that region far prefers his blowgun to the noisy and heavier fire arms. With a little quiver of perhaps a hundred arrows, made from the midrib of one of the palm leaves, the hard fiber sharpened to a needle point at one end, slightly charred to make it harder, and the butt-end tightly wrapped with wild cotton to fit snug in the tube of his blowgun, he has an overabundance of ammunition, for he is an excellent shot, and a good stalker of game, taking few chances and wasting few arrows. His blowgun is the dual product of the swampy plains and the upland streams; the former furnishing the stronger, heavier outer bamboo sheath with easily extracted joint-pith and the latter the inner tube, a species of reed, which frequently grows to ten or twelve feet between joints, and is, in selected cases, so straight that a plummet line detects no bend nor inequality. This easily carried outfit has two prime advantages, especially in the search for such elusive game as the monkeys; it does not mutilate them, as a charge of shot may do, and its almost silent "puff" does not frighten away every survivor, as is the case when they take to their heels over the tree tops after the solemn quiet of a tropical forest is shocked by the firing of a gun. If this is true of game wanted for food or for museum uses, it is doubly so of specimens to be sent to market alive. With a knowledge and a quick use of the antidote, and the use of arrows not charged with a full strength Wourali, it is possible for the native to temporarily paralyze his intended captive with the first effects of the Wourali and yet, with a prompt use of the antidote, to restore him to activity and to comparative health in a short time. In this way, and only so, can certain species of monkeys be procured alive; for your average monkey is far better able to fathom and escape the mysteries of a native's trap than is the latter able to devise a mechanism capable of deceiving simian inquisitiveness.

As to the composition of this antidote, I regret that I give no definite information. All that can be said is that it undoubtedly exists; that common salt is always procured by the natives preparatory to making it (this is quite as likely to be a "blind" as a genuine need); and that it is used in solution on raw cotton and some drops of it squeezed into the mouth of the poison's victim and still more into the wound, following which artificial respiration, by manipulation of the arms or forelegs, is maintained until consciousness and activity return. It seems to be only possible to procure the antidote already on the cotton. I have heard of no sale of it in the liquid state, nor of any outsider allowed to witness its preparation. Nor would a considerable bribe of nickeled gewgaws and colored two-page pictures from Puck and Judge, prime legal tender in all that region, tempt any adept to the divulgment of this much-prized formula.

There is a wide divergence of opinion, however, among the native users of Wourali as to the reliability of the antidote. No one is to be found, apparently, who would exemplify its use on himself, and not a few profess to have discovered that the weakness of the Wourali used, in such cases, and the artificial respiration maintained, are at the bottom of the recoveries credited to the antidote. I have, however, tried the antidote on wounded birds and small game with fair results, and with the birds I have never attempted artificial respiration. Perhaps two-thirds recovered, although all seemed stupid and benumbed for many hours and refused food for several days. That, on the other hand, artificial respiration has much to be said in its favor, the following accounts given by Waterton prove. Speaking of experiments conducted by himself during one of his vacations in England, he says:

"During that time several experiments were made with the Wourali poison. In London an ass was inoculated with it, and died in twelve minutes. The poison was inserted into the leg of another, round which a bandage had been previously tied a little above the place where the Wourali was introduced. He walked as though all were right. After an hour had elapsed, the bandage was untied, and ten minutes after, death overtook him.

"A she ass received the Wourali poison in the shoulder and died, apparently, in ten minutes. An incision was made in her windpipe, and through it the lungs were regularly inflated for two hours with a pair of bellows. The ass held up her head and looked around; but, the inflating being discontinued, she sunk once more in apparent death. The artificial breathing was immediately commenced and continued without intermission for two hours more. This saved the ass from final dissolution; she rose up and walked about; she seemed neither in agitation nor in pain. The wound through which the poison entered healed without difficulty."

In continuation of this account, Waterton says that, having been christened "Wouralia," this ass was sent to Walton Hall, the country seat of Earl Percy, where for nearly twenty-five years she lived a life of indolence and plenty in recognition of her services in the interest of the science of toxicology.

Another of Waterton's graphic narrations is well worth repeating. He writes of an incident on his first trip inland, up the valley of the Essiquibo, thus:

"At one of these habitations a small quantity of the Wourali poison was procured. It was in a little gourd. The Indian who had it said that it had killed a number of wild hogs and tapirs. Appearances seemed to confirm what he said, for on one side it had been nearly taken out to the bottom at different times, which probably would not have been the case had the first or second trial failed.

"Its strength was proved on a middle-sized dog. He was wounded in the thigh, in order that there might be no possibility of touching a vital spot. In three or four minutes he began to be affected, smelt at every little thing on the ground around him, and looked wistfully at the wounded part. Soon after this he staggered, laid himself down, and never rose more. He barked once, though not as if in pain. His voice was low and weak, and in a second attempt it quite failed him. He now put his head betwixt his forelegs, and, raising it slowly again, he fell over on his side. His eyes immediately became fixed, and, though his extremities every now and then shot convulsively, he never showed the least desire to raise up his head. His heart fluttered much from the time he lay down, and at intervals beat very strong; then stopped for a moment or two, and then beat again, and continued faintly beating several minutes after every other part of his body seemed dead. In a quarter of an hour after he had received the poison he was quite motionless."

In all of the foregoing cases it will be observed that everything was done to test the deadly power of the Wourali in the extreme. In the following experiments, made among many others, I sought to test Wourali for its efficiency as an aid to the collecting naturalist; to see, in a word, how quickly it could end life in various orders of vertebrates, if used in the most favorable way. I was especially desirous of finding some poison that would quickly render harmless a poisonous snake, so that it could safely be handled and put in the preserving jar at once; a poison that would take the place of the potassium cyanide needle, because of the extreme danger in handling that death-dealing instrument. I soon discovered, however, that a quality of Wourali of sufficient strength to promptly do the work I desired of it was well nigh as dangerous to mankind as the better known drug, judging from experiments on minor mammals.

There are two features of the use of Wourali that render experimentation with it much less unpleasant than such work is usually apt to be; these are the apparently painless manner in which its victims are killed and the fact that such experiments can be conducted on animals doomed to death for food purposes, because the introduction of the Wourali poison into them does not affect the edibility of their flesh. Thus the interests of science are advanced while terminating the life of the creature experimented upon in a far more humane manner than is usually the case in our slaughter houses. Commenting on the ease of death by this method, Waterton says:

"The Wourali poison destroys life's action so gently that the victim appears to be in no pain whatever; and probably, were the truth known, it feels none, saving the momentary smart at the time the arrow enters."

A steel-tipped dart coated with full strength Wourali introduced near the base of the brain in a large specimen of our common blacksnake rendered it perfectly motionless in less than two minutes; but a like wound made with half strength Wourali on a snake of somewhat less size only practically benumbed it, but did not greatly weaken its contracting and squirming powers.

Full strength Wourali introduced on a small dart into the base of the tongue of a pigeon killed it in but a little over sixty seconds; the same injection in a pigeon applied in the fatty tissue at the root of the tail took nearly three minutes to produce death. These were simply indicative of the rate of poison distribution through the circulation of the animals experimented on, and are typical of other like trials made on various animals.

Wourali, of full strength and in an ample quantity, will kill a full grown hog in about four minutes, if injected at the root of the tongue; it will take three times that length of time to produce the same effect with an injection in the thigh. This corresponds with like experiments made by Waterton on an ox. A monkey of the blue-faced cebus tribe, wounded in the leg, sought a deep hollow at the juncture of a principal limb with the trunk of the tree in which he was jumping when shot by a heavily charged dart. There he could be seen, picking at the wound and slowly rocking to and fro and dubiously shaking his head from side to side in a most distressingly human sort of way. In about a minute and a half his hold on the tree relaxed, he turned on his side and came tumbling to the ground, apparently dead, although a faint fluttering of the heart was afterward discernible. Had he been shot with a load of shot, unless so hit as to kill him instantly and literally knock him out of the tree, his death paroxysms would only have rendered his grip more secure and rigid and the hunter would have simply had a dead monkey, high up a tree practically inaccessible to a climber, because of the girth of its trunk and the great height to the first limbs.

Curarine, the toxic principle of Wourali, was strongly recommended to me as a remedy of sovereign power in controlling and lessening the more painful symptoms common to cancer of the vagina, uterus, etc. I was well aware of the ex cathedra verdict of the U. S. Dispensatory, wherein it is said that, "as a remedy curare has very little value, even in tetanus, hydrophobia and other convulsive affections; it will, undoubtedly, quiet the spasm, but does not have any direct curative influence on the disease."

However, beginning on the basis set down by Du Cazel,* that the subcutaneous dose for man is from 1 to 5 centigrammes, exceptionally even 6 to 7, I gave it a most thorough chance to prove its worth under the eyes of skilled and cautious observers; but with absolutely negative results. In the field of therapeutics, I believe Wourali to be a negligible quantity. As a remedy to be taken into the stomach, being a poison whose active principle passes through animal membranes with difficulty, it acts so slowly when thus taken that in many cases it may be eliminated so rapidly as to have but little, if any, marked influence on the patient.

Curarine, unlike most crystallizable alkaloids, contains no oxygen; carbon, hydrogen and nitrogen being its elements. In proposing a provisional formula for it, Preyer offered C_{19} H_{15} N as best expressive of its composition. Sachs, believing Preyer's specimens of the alkaloid to be impure, gives C_{13} H_{20} N as the correct formula.

Death from Wourali has generally been attributed to paralysis of the respiratory nerves, but Dogiel and Nikolski affirm that the respiratory centers are paralyzed. The latter theory corresponds with my own personal sensations.

Starting with three centigrammes as a moderate subcutaneous (right arm) injection, I slowly worked my way up, allowing at least two weeks to elapse between each trial. Three and even four centigrammes did not produce any very appreciable results, other than to cause some dizziness, slight vertigo, a considerable degree of lassitude and an extremely painful headache of rather unusual duration. But five centigrammes considerably improved upon this, causing a degree of vertigo and lassitude that were most distressing, and six centigrammes, my major injection, gave me one of the frights of my life.

Perhaps I did unwisely in giving myself the largest injection on a day when I was overheated and slightly below par otherwise; however that may be, the added centigramme produced so much more on top of the five centigrammes experiment, that for a time I had reason to fear that that addition was just the amount needed to bring my experiments to a permanent close.

Within three minutes of the time of the injection, the dizziness and vertigo had become so great as to make walking impossible; yet, in another minute the lassitude rapidly creeping over me and the serious disturbance of my breathing apparatus made it apparent that walking, gesticulating, and even an attempt at mild athletics were imperative. My lungs felt glued up, and the muscles of my chest flatly refused to work; everything swam before my eyes, and I was soon reduced to walking up and down the porch of my bungalow, with halting steps, only preventing falling by holding fast to its railing. It seemed to me that I spent hours in that sort of gasping for breath experienced in the Cave of the Winds, Niagara, where water is more abundant in the atmosphere than air. My watch afterward indicated only about twenty minutes of extreme distress; but that twenty minutes was one never to be forgotten and I advise all experimenters, however robust or valiant, to remain below the five centigramme limit.

As a fitting close to this article, let me quote the description of a Macoushi Indian who had seen his comrade accidentally go beyond my limit, with fatal effect. The two had been out after tapir-meat together, and the doomed man had taken a long-chance shot at a monkey in the treetops. The dart had missed its elusive target and gone out of sight; evidently on its return to earth it had struck a limb and been deflected in its course, for suddenly the hunter was aware of its presence in his quivering arm.

To translate the Indian's brief narrative, without detracting from its style, he may be quoted thus:

"Quacca takes the dart out; never a word. Puts it in quiver and throws it in river. Gives me his blowpipe for his little son. Says to me goodby for his wife and the village. Then he lays down, for he is very faint. His legs will not walk; his tongue talks no longer; no sight in his eyes. He folds his arms; he rolls slowly over; his mouth moves without sound. I feel his heart, it goes fast and then slow. It stops. Quacca has shot the last Wourali dart."

* Archives Generales, September, 1869.

HYGIENIC CAMPS.*

By H. R. HOPKINS, M.D., Professor of Hygiene, University of Buffalo, N. Y.

IN the war of the Crimea, with 1,460,500 troops, there were killed in battle 53,870; died of wounds, 66,600; died of disease, 492,200. In the American war of 1861–5, in the Northern army, there took the field 2,336,000 troops; there were killed in battle 44,240; there died of wounds 34,006; there died from disease 149,240.

In the American-Spanish war there took the field 274,717 troops; there were killed in battle 293; there were wounded 1,577; there died from disease 2,619.

In the American war of 1861–5 there died from camp diseases, diarrhœa, dysentery, and camp fevers, 85,214.

The report of the United States Commissioner of Pensions in 1898 shows upon the pension roll 993,714. The United States government has disbursed for pensions since the war of 1865, $2,327,525,237. In 1880 the bacillus of typhoid fever was discovered by Eberth. In the same year Sternberg discovered the pneumococcus of pneumonia. In 1882 Koch discovered the bacillus of tuberculosis; in 1884, the bacillus of cholera. In the same year Loeffler discovered the bacillus of diphtheria. In 1892 Canon and Pfeiffer discovered the bacillus of influenza and the supposed bacillus of measles.

It is the common knowledge of all informed men that from the earliest times the fatality attending camp life is far in excess of that attending the march or line of battle. There has been no exception to this experience. If it were not that there has come into the minds of sanitarians within the last thirty years something which is important and new, there might possibly be criticism as to the expediency of discussing this question at this time; but within the last thirty years, since the civil war, discoveries have been made as to the nature of the communicable diseases, discoveries which are of such an important character that the subject of the communication of these diseases needs to be restated and discussed anew, in so far as their prevention in camp is concerned.

Prior to thirty years ago we had opinions as to how diphtheria was communicated, and in regard to the spread of dysentery, but we had nothing but opinions, and our practice was of the vague and uncertain character which always attends action when that action is guided simply by opinion. But the labors of the microscopist and bacteriologist have replaced these opinions with more solid scientific material, which produces in the mind conviction, a very different affair. We now know positively how typhoid fever is communicated; we know accurately how diphtheria is communicated, and for that reason it is proper that we should discuss the question of hygienic camps.

Permit me a single moment as to the trend such discussions should take. It would seem that the time has passed when the philosophy of the hygienic camp should be discussed, and I do not propose spending time to discuss it. The time has come when we should concentrate our efforts upon the consideration of the means of demonstrated value which may be put into operation in military life to produce those conditions of health for which they have proved adequate over and over again in civil life. We are not to discuss philosophy nor expediency nor desirability; we have moved on beyond these, and will discuss the approved appliances of civil life which may be adapted to camp life, to the end that the same beneficial results, the prevention of disease, will prevail in the camp that have been known to follow under civil conditions. We will present the means by which our camps may have the sim-

* Abstract of paper read at the meeting of the Medical Society of the State of New York, January 31, 1899.—The Sanitarian.

ple but priceless advantage of clean soil, pure water, fresh air, and, therefore, possibly be hygienic camps.

It may be observed that the hygienic camp of instruction must answer all military necessities, and that the appliances of hygiene must never conflict with or run counter to the requirements of the school of the soldier. Therefore, in the selection of a hygienic camp, the requirements of the commissary department, quartermaster's department, and the medical department must be met. In case of a conflict among these various departments, the officer in command, of course, makes the decision.

Experience is equally clear in determining that the first requisite of a hygienic camp is a clean soil. This principle must be absolutely observed in the selection of the camp site. The soil once clean must be kept clean at any cost. The question is one of exceeding simplicity, and simply requires means for the removal from the camp of all the solid and liquid excretions of the men. To accomplish this, it is necessary that the hygienic abomination, the camp sink, be abolished, care being taken that sewers of sufficient capacity, with adequate fall, with convenient openings, be provided for the necessity of the troops. The cost of this work, including the digging of trenches, laying the sewer pipe, and the necessary traps for a camp for a regiment of 1,300 officers and men will not be beyond $1,000. The time necessary for the prosecution of this work need not be more than one week.

The next requisite for the hygienic camp is to provide for the camp a bountiful supply of pure water, piped from a convenient distance, of sufficient force and volume to provide for the suitable flushing of the sewers. Taps should also be at the head of each company street, in each company kitchen, in the bath tents of officers and men, and wherever required. The cost of this apparatus, yielding forty gallons of water per day per man, will not exceed per regiment, $4,000; per brigade, $6,500; per division, $12,000. In case the water supply of the camp is not absolutely above suspicion, a distilling apparatus capable of distilling all the water required in the camp for drinking and culinary purposes should be provided. The cost of such distilling apparatus for a regimental camp will not exceed $2,000. Should it be thought by any that such camp sanitation, even if efficient, would be too expensive, it is only necessary to call their attention to the fact that sanitary appliances are already in use in the navy of this country, the cost of which far exceeds the estimate necessary to make absolutely hygienic camps.

The ventilating system on the battleship "Oregon" has been estimated by the Bureau of Equipment of the Navy Department to cost $50,000. This investment is for the protection of the health of a complement of 424 officers and men. The Navy Department expends in the distilling apparatus of the ships of our navy sums which equal $50 per man. It may be observed that this expenditure has never yet been faulted, and it would seem that the lives and efficiency of our men at arms on land are equally valuable with those at sea.

In a hygienic camp provision must also be made for the daily cremation of all camp refuse of an organic nature. The cost of suitable apparatus for this important part of camp sanitation would not exceed a few hundred dollars.

Keeping in mind the importance of the preservation of the soil, it is necessary that certain parts of the camp be provided with a concrete or other impervious covering. This is more particularly the case at the bath tents, company kitchens, urinals, and such other parts of the camp as are more liable to organic contamination. The cost to provide for this covering would be at the rate of 15 to 20 cents per square foot, and the provision for all the points liable to soil contamination of a camp would not exceed $700.

In camps of instruction a principle of extension has been introduced for sanitary purposes, and although the great numbers of the regiment live in a compacted space—perhaps one-third of the entire camp space—the whole camp was extended at its two ends, with sinks for the soldiers on one side and for the officers on the opposite.

This principle of extension was the best makeshift of the time, but it is obsolete in the presence of appliances for sewering and properly flushing a camp, the fact being that the tent for closets 50 feet away is farther away than the camp sink at 500 feet.

The above items are not the opinion of the speaker, but are the estimates gathered from expert practical men in their several lines that may be considered absolutely reliable. They show the cost of sanitary appliances for the hygienic camp are, for sewering, $1,000; for water supply, $4,000; for concrete, $700; giving a total of $5,700 as the expense for a camp of a full regiment. In considering this matter you must not lose sight of the fact that these sanitary appliances are practically imperishable; at least they are likely to be serviceable for many years. The interest of $5,700 at 4 per cent. is $228 per year.

NOTES ON THE ABYSSINIANS.

THE predominance of military life in Abyssinia is so striking as to absorb one's attention almost exclusively. There are other things, however, that are sufficiently interesting and characteristic to merit a moment's notice. Religion, for example, and especially the way in which it is understood and practiced, might form the subject of some curious observations. As very little is known about the propagation and establishment of the Coptic cult, let us, in a few words, recall the prominent stages in its history. The conversion of the Abyssinians to Christianity dates back to the beginning of the fourth century. At this epoch, a Christian traveler named Frumence was shipwrecked upon the Ethiopian coast of the Red Sea.

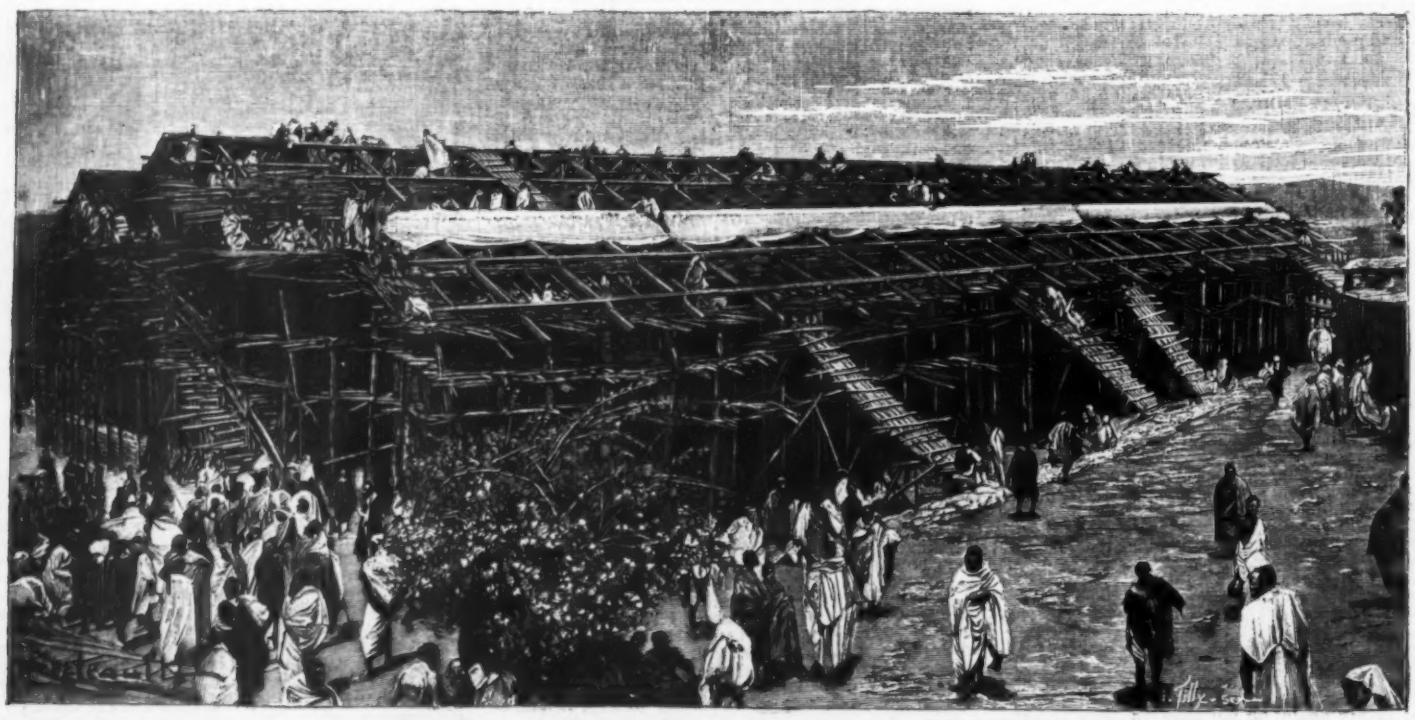
Received by the inhabitants, he remained among them and devoted himself to the propagation of his faith with such zeal that his converts soon became a host. The King of Ethiopia having himself been won over to the new religion, entered into relations with the Church of Alexandria, at the head of which was Patriarch Anastasius. Bishops were then sent over and, having established themselves in the country, worked with great energy in the propagation of Coptic Catholicism. During the troubles brought about through the schism of Dioscorus, the patriarchate fell into the hands of the monophysite Copts. Just at this epoch, the Emperor of Ethiopia, entirely ignorant of these dissensions, asked for some new prelates. As the Church of Alexandria was then controlled by Jacobites, it was naturally Jacobite prelates that were sent. And so, by mere chance, Ethiopia became schismatic.

In the sixteenth century, Emperor Constantine Zara Jacob, desirous of reconciling himself with the Holy See, sent a deputation to the Council of Florence, which resulted in the advent in Ethiopia of Portuguese Jesuits, who succeeded in maintaining themselves there from 1531 to 1638. Nevertheless, despite all their efforts, Catholicism could not succeed in resuming the first rank and violent persecutions soon put an end to its influence. Abyssinia is now almost entirely devoted to the Coptic cult, and is less than ever disposed to submit to other religious influences.

The Empress Taïton is the great protectress of the present clergy and the firm supporter of old Ethiopian customs and traditions. Europeans have not in Abyssinia a more irreconcilable enemy than she, except it be the clergy. The good sense of the Negus, along with his breadth of mind, fortunately tempers the unrelenting spirit of this reactionary party. But the church exerts so formidable an influence that it is impossible to treat with it without great circumspection.

AN ABYSSINIAN SOLDIER IN WAR COSTUME.

The Abyssinians celebrate the beginning of a new year by the "Mascale," a period of five days of festivities. Then comes their Easter, which falls upon the fifth day after our own, and succeeds a rigorous fast during which meat, milk-food and the majority of vegetables are prohibited. Cakes of teff or maize and roasted chick-peas form the meager fare that the Coptic Church imposes upon the faithful for a period of forty days. Noisy demonstrations of joy succeed this fast, and up to a short time ago gunpowder played a part in the manifestations of popular pleasure, and discharges of musketry were heard everywhere and in all directions. The Negus had to forbid this dangerous amusement, and the fête, which is better regulated now, takes place in the Quebi, that is to say, within the inclosure of the royal residence. Here occurs the "Holy Saturday"—a ceremony never to be forgotten. The churches of the capital, about fifteen in number, each having



CONSTRUCTION OF THE NEGUS' NEW PALACE, OR ADERACHE.

its prelate, its curates and its monks, have to announce to the Emperor the event of the Resurrection. At the back of the court stands a huge tent designed to protect the rising seats covered with oriental carpets. In the center is the throne. To the left there is a row of seats designed for the use of European guests. Two bishops station themselves upon each side of the Negus, while opposite the great tent are massed the priests, monks, and the entire personnel of the church in a compact group. Then, arranged in a semi-circle, comes a crowd of curates, in richly embroidered mantles of garnet, orange, and violet velvet, and holding large multi-colored umbrellas over the objects of worship which they have in charge.

The ceremony begins at ten o'clock in the morning. The heads of the first church advance, intoning canticles in the Gheez language, which the curates take up and accompany with measured gestures, while the monks pound upon drums in cadence. Having arrived in front of the imperial throne, all the priests prostrate

AN ABYSSINIAN MAIDEN ON THE WAY TO HER MARRIAGE.

themselves; and then (this time with precipitate steps, and accelerating the cadence, songs and gestures) abruptly recede, advance, and recede again, each time with more rapid steps and with louder song. Finally, after a last reverence, all the noise and motion ceases at the feet of the Emperor.

The same ceremonial is performed by each of the churches with identically the same phases. There are a few differences of detail, however, since each church tries to surpass its rivals, either by the number of its monks and curates or by its canticles and costumes. The same scenes are thus reproduced without rest until evening.

Upon the next day, Easter Sunday, the soldiers are, as at every great festival, invited to the royal table, upon which are served fine cakes soaked in sauces of red pepper, raw beef (the national dish), and hydromel served in buffalo horns. But, in recent years, the army having increased to such proportions that the common hall, the "Aderache," became too small to accommodate it, the Negus, two years ago, ordered the construction of an immense building in which eight thousand invited guests might be able to partake of a repast.

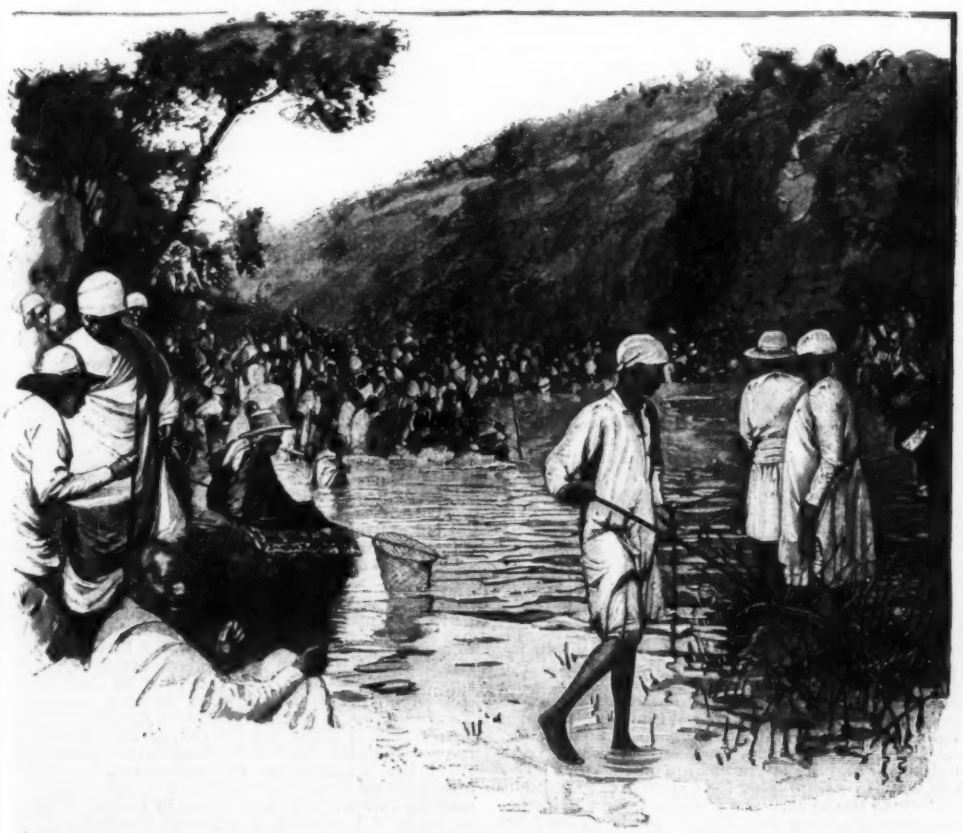
When Emperor Menelik decides upon a thing, the execution of it has to be rapid. So the new Aderache, which was begun at the end of 1897, was inaugurated on the fifth of last June.

M. Ilg was put in charge of the work, but the Emperor himself, who was constantly upon the spot, did not fear to take a hand in it, and the Ras, the Dedjaz and the Europeans who came to solicit the imperial favor for urgent affairs were obliged to follow his majesty's example.

Externally, the new palace is far from being architectural. It reminds one of a European factory with the ordinary roof replaced by one of thatch. The internal appearance is more attractive. The framework is light and the innumerable colored cords that connect the laths forming the ceiling produce quite an original effect and serve to relieve to a certain extent the somewhat somber aspect of the hall.

This Aderache, during the period of its construction, made the numerous ambassadors sent to Addis-Abeba desperate. When the Emperor saw himself forced to grant too many audiences in a day or pressed to accord a favor, he climbed up his Aderache. All sovereigns, along with their ministers, ought to have an Aderache!

It must not be concluded from this that the Negus holds the representatives of old Europe in contempt. He finds them somewhat of a bore, that is all; and, perhaps in virtue of the old adage, "Divide in order to reign," he has comfortably lodged them at the four corners of his capital. So there are no incidents. An hour's run upon mule back separates the ambassadors from each other. Visits to the embassies are not the only occasions upon which the Negus leaves his palace, for he likes to go about and see what is doing in his own capital. Sometimes he gives his promenades a less serious character and takes a direction toward the little river Akaki in order to fish, not with the hook and line, but with dynamite. The crowd that follows him on such an occasion is particularly large. The procession is preceded by trumpeters, and then follow servants carrying his majesty's scarlet umbrella, his guns in their cases, his folding chair, and the gold-fringed green silk that covers the imperial mule during stoppages.



THE NEGUS OF ABYSSINIA FISHING WITH DYNAMITE IN THE RIVER AKAKI.

We must not forget to mention the inevitable group of guards armed to the teeth, whose brilliant accouterments should be seen in order to be appreciated. On occasions of great ceremonies they are clad in a long silken tunic striped with hundreds of colors and ornamented with a multitude of gilded buttons. Their headgear consists of lions' manes and diadems of gold and silver, and their weapons are guns and sabers which rival each other in brilliancy and richness. Their bucklers especially are remarkable, formed, as they are, of leather or velvet of warm shades, and ornamented with plates of gilded silver, in open work, resembling jewelry. These are presents from the "Master," for a soldier could not purchase a buckler thus ornamented at any price. It is given to him after a brilliant action in which he has distinguished himself.

The Ras and Dedjaz also have the right to reward their men with analogous presents, manufactured by their own workmen; for, as is perhaps well known, each governor of a province has his own army, and his own military and civil house patterned after that of the Emperor. The number of the functionaries and soldiers alone differs. Despite this independent organization, the great chiefs remain in some respects under a narrow dependency. Justice, for example, springs directly from the Emperor, and the "Wambers," or judges, distributed throughout all the provinces, are, in a manner, the discreet surveillants of the doings of the governors. Judicially, they are dependents of the great judge—the Affa-Negus, or "Mouth of the Negus." Parties can always appeal from the decisions of this high magistrate, and, as a last resort, even from those of the Emperor; but this can occur only when the case is of great importance.

In case of a simple disagreement, the Abyssinians have recourse to a singular method of settling it. They stop the first passers-by, select a judge from among them, and proceed to plead their case before the court thus constituted. The one who is decided to be in the wrong is sentenced to pay a fine of a few thalers in cash or sometimes of a sheep. Before the Affa-Negus, who renders justice in the open air, the procedure is identical. Although the profession of advocate is not entirely unknown, every Abyssinian is anxious to act as his own counsel. After the Affa-Negus has patiently listened to the long speeches of these self-constituted attorneys, the decision that he renders is listened to in silence, and the victor then prostrates himself before the judge and kisses the earth several times as a token of his gratitude.

Divorces are the simplest cases that are tried. The parties present themselves before the judge, who, after listening to their statements, decides how much of the common property each is to retain after the separation; and, without any other form of trial, the two retire in order to engage in new bonds of wedlock as soon as they shall see fit. As a general thing, the husband and wife, upon separating, take the original marriage portion plus half of the property amassed while living together. It follows that at every divorce the women find themselves better off and are capable of pretending to a more and more advantageous marriage. The chiefs, in order to prevent themselves from being thus despoiled of a portion of their property, frequently select Galla women for wives, as the law does not permit these to demand a separation. The Galla maiden is, so to speak, purchased from her parents, and her condition becomes about that of a woman of the harem in Turkey.

Although divorce has the simplicity of a formality, a marriage with an Abyssinian or a Galla woman is always a pretext for great festivities, which generally take place under the roof of the fiancée's family. All the friends of the two families are invited, and dances and songs are indulged in until daybreak and are interrupted only by a formidable repast, after which the future bride and bridegroom are blessed by a priest. Then comes an enumeration of the chattels of the new household. The libations are afterward resumed, while the "asmaris" (corresponding to the ancient poets of the north of France) sing the noble deeds of the bridegroom and the titles of the two families to glory. The bride then appears with her head well buttered and entirely enveloped in a fine "chama" of white cotton and proceeds to mount a superbly harnessed horse. The bridegroom in turn comes up on a gallop, while the excited crowd fires guns and sets up an unearthly yell as the wedded pair start on their way to take possession of their domicile. But this does not end the festivities, for the people assemble at the house of one person or another for the next three days in order worthily to celebrate the happy event. The longer the rejoicings last, the greater will be the renown of the new household.

For the above particulars and the accompanying engravings we are indebted to L'Illustration.

According to the Annuaire de la Presse, there are, in all France, 6,417 journals of all descriptions. Of these, five-twelfths, or 2,588, are printed in Paris, the remainder being distributed in other towns and cities. Of those printed in Paris, there are as follows:

Medical, surgical, hygienic, pharmaceutical, etc.	206
Financial	195
Reviews, literary, political, etc.	162
Political	144
Illustrated journals	121
Fashions, tailoring, hair dressing, etc.	113
Educational	101
Jurisprudence, law, etc.	93
Bulletins of associations, societies, etc.	87
Miscellaneous	1,366

It is rather curious to note that the number of journals devoted to medicine and its various branches exceeds all other class literature, even political. The greater part of them, however, are merely advertising sheets devoted to the "reclamation" of pharmaceutical specialties. Of true journals of pharmacy, there are seven only.

ENGINEERING NOTES.

The following are the leading particulars of the Boston Elevated Railway: Miles of line operated, 305; number of cars, 2,648; car miles during 1898, 29,787,000; passengers carried during 1898, 172,764,300; number of power stations, 5; total capacity of power stations in kilowatts, 16,100; total rated indicated horse power of engines, 24,000.

The cause of the frequent cracking of crucibles may be traced to the fact that the walls contain moisture. With quick heating the moisture is transformed into steam which cannot escape quickly enough, and, in consequence of overheating, expands, until finally the walls of the crucible can no longer resist it, thus causing the cracking at the largest diameter. In order to guard against this evil, it is advisable to heat the crucible slowly before use, so that the moisture held in its walls can evaporate. According to a German metallurgical contemporary, this previous heating should be done, even if the crucible is well dried out, not having been used for melting, but kept in damp and cold rooms.

One of the oldest bridges in Europe is soon to disappear under the demand for better navigation of the river it spans, says Engineering News. This is the stone bridge, with fifteen arches and a total length of 994 feet, built across the Danube at Ratisbon, by Duke Henry the Superb, in 1135-46. The piers rest on piles protected by stone riprap and heavy ice breakers; the roadway is very narrow and the footways allow the passage of only one person at a time. Hans Sachs, the poet-shoemaker, of Nuremberg, sang its praises as one of the wonders of the builders' art and the strongest bridge in Germany. So far as its stability is concerned, it would probably stand for another 750 years —but it interferes with the passage of steamboats.

We have official information, says The Railway Review, that the White Pass and Yukon Railway has now pushed its roadbed construction eight miles beyond Log Cabin, B. C., but there is considerable rock work yet to be done between the Summit and Log Cabin, along the shores of the Summit lakes. There is at present a force of about 600 men at work, and as soon as the weather improves, this number will be increased and construction advanced as rapidly as possible. It is now expected that Lake Bennett will be reached with the rails about July 1, or August 1 at latest. Much depends upon the ability of the company to hold its laborers, as the force is being constantly reduced by reports of gold strikes in various parts of the country. The company is now constructing twenty box and flat cars in addition to rolling stock previously reported.

Some particulars of the Theisen process of scrubbing blast furnace gases recently appeared in our German contemporary, Stahl und Eisen. In this process very thin layers of the gases are mixed with the water or lye. A centrifugal scrubber is used, which brings the gases into intimate contact with the cooling water, and is stated to take out the very finest particles of dust. An artificial draught corresponding to 1 to 1¾ inches of water is created. The water, after taking up the dust, is drained into a settling basin, and may be used over again. It is stated that an apparatus 7 feet high and 8 feet in diameter can deal with 10,600 cubic feet per minute. In saving by-products, it is found that the tar is first thrown out of the gases, and that cooling towers are not necessary, as the tar is completely removed, and is, moreover, nearly free from water, on account of the initial high temperature of the gases at the place of separation. The separation of ammonia water and benzene is also provided for.

It is customary to submit indicator springs to a test before and after the respective engine tests, and to take the mean value for the calculations. It would also be advisable to test the accuracy of every new indicator. In engineering laboratories such tests can readily be made, of course, but the practical engineer has not the necessary apparatus at his disposal, and cannot do much without taking the spring out of the box. Prof. Dwelshauvers-Déry, of Liége, has devised a simple contrivance to obviate this necessity. It consists of a frame and a rod fitted over the spring in the box, to which weights are attached. One frame is used for testing the spring under compression, another for working under tension. In neither case need the spring be removed from the box, so that the correct temperature limits can be observed without difficulty. The professor also recommends a special spring of small compressibility for the vacuum line in cases when high pressure and vacuum alternate, as occurs in single cylinder condensing engines. The vacuum line will then appear more accurately on enlarged scale.

The first steam engine to be erected on the American continent was set up at Belleville, near Newark, N. J., in 1753. Part of the cylinder of the engine is now at the National Museum at Washington, D. C., but it has been subjected to so much wear and exposure that it is not possible to judge as to the quality of the workmanship. It is very noticeable, however, that mechanics were not perfect in the "good old times" any more than they are now-a-days, for mistakes were made in drilling the flange of the cylinder, and extra holes had to be drilled "off center" to correspond with the part of the machine that joined the flange. Another interesting exhibit at this museum relates to dividing wheels, a subject which most mechanics probably associate entirely with modern shop practice. Nevertheless, a mechanic and scientist of the name of Jesse Ramsden made a machine in 1775 for cutting the teeth of a hob which he afterward used to hob the teeth of the large wormwheel of a dividing engine. The machine is provided with change gears similar to an engine lathe and is said to be the first example of the principle now used in screw cutting. The wheel of the dividing engine has 2,160 teeth, and it would be a good problem for some of the bright young mechanics of to-day, who are expected to be well informed in such matters, to make all the calculations necessary for designing the hob and wormwheel and the machines for cutting them. Both the lathe for cutting the hob and the dividing engine are in a good state of preservation and have a new and modern look about them.—Machinery.

MISCELLANEOUS NOTES.

The figures relating to the production of wine in Algeria show the steadily increasing importance of the industry. A very large proportion of the total production is received in France, where it is used in combination with other wines to produce the article which the trade requires. The yield of 1898 is given as 5,221,700 hectoliters, or, in round figures, 115,000,000 gallons. The area of the vineyards reached a total of 123,960 hectares, or 306,000 acres. In 1880 the production was 12,000,000 gallons; in 1888, 70,000,000 gallons; and in 1897, 113,000,000 gallons.

The smallest state in Europe is Tavolaro, an island on the northwest coast of Sardinia, three miles long by about half a mile wide and having fifty-five inhabitants. From 1836 to 1882 this island was a monarchy under the kingship of Paul I., who, at his death, expressed the wish that a republican form of government be instituted. This was done, and Tavolaro is now ruled by a president chosen from among its fifty-five inhabitants for a term of six years. The women vote as well as the men. Tavolaro was formerly called Buccina, and was renamed for a variety of rock shell particularly appreciated for its purple.

"The story comes," says The Bulletin of Pharmacy, "of a Russian physician who placed a dog in a room with the temperature lowered to 100° F. below zero by the use of liquid air. After ten hours the dog was taken out alive and with an enormous appetite. The physician tried the test himself. After ten hours' confinement in an atmosphere of still, dry cold, his system was intensely stimulated. So much combustion had been required to keep the body warm that an intense appetite was created. The process was continued on the man and the dog, and both grew speedily fat and vigorous. It was like a visit to a bracing northern climate."

In Comptes Rendus M. Mourelo states that he has made the curious discovery that sulphides of strontium, calcium, barium, and zinc, prepared in a particular way, show much more brilliant phosphorescence after exposure to diffused daylight than they do after exposure to direct sunlight, and, further, that periodic exposure to diffused daylight increases very remarkably the power of phosphorescing. After being brought to this sensitive state, one phosphorescing portion is able to excite phosphorescence in another non-luminous portion, either when the two portions are in contact or when they are contained in separate glass tubes.—Electrical Review.

A. Gautier finds that iodine in the state of vapor does not occur in the air, either in that collected in Paris, or in woods, on mountains, or at sea; nor does it occur in the form of soluble salts, but that it is found in minute traces in an insoluble form in the air of Paris, and to a much greater extent in sea air, being probably combined in microscopic vegetations, such as algæ, lichens, and spores floating in the air. A specimen of fine dust collected under the colonnade of the Panthéon at Paris at a height of 40 meters was found to yield 0·066 per million of iodine, and the dust in the form of a greenish black lichenoid incrustation adhering to the stones of the same building, at a height of 77 meters, gave no less than 0·551 part per million of the metalloid. One thousand liters of Paris air contained 0·0013 milligramme of this combined iodine. The same quantity of sea air contained 0·0167 milligramme.—Comptes Rendus.

The University of Chicago has set aside $5,000 to defray the expenses of explorations which are about to be conducted under its auspices in Yucatan. A collection of hitherto unknown ruins have been discovered lately some distance southeast of the city of Merida, on the north coast, and a representative of the institution paid a visit to the spot this winter. He found the remains of what seemed to be an enormous tribal dwelling, with buildings scattered around it over an area of nearly a mile. The main edifice was built massively of stone, and the façades were literally covered with the most intricate and beautiful carving. The top is covered with earth and vegetation, and from a distance looks like a square wooded hill, so there is fairly good reason for supposing that the interior rooms are in a state of good preservation, at least that they have not been opened and ransacked by prowling Indians. There are many tombs also that have every appearance of being intact, and if so, they may contain much matter to shed light on one of the most mysterious pages of the history of humanity. The exploring expedition will start some time within the next month, and New Orleans will be its point of departure.—Boston Transcript.

A continuous waterway from Lake Superior to the Rocky Mountains in British possessions is contemplated, according to a St. Paul dispatch. The costliest portion of the work would be between Lake Superior and Rainy Lake, where canals would be required over the height of land to reach Rainy Lake. From the last-mentioned point to Edmonton, on the Saskatchewan River, the work would be comparatively light. Thence there is clear navigation across the Lake of the Woods to the Rosseau River, which flows into the Red River. Down the Rosseau to the Red the fall is gentle. The lake and two rivers are almost of the same level, and the dredging of a channel through a flat, marshy tract would give boats access to the Red River. Thence there would be clear sailing to the Saskatchewan by way of the Red River and Lake Winnipeg. At the mouth of the Saskatchewan the Grand Rapids would have to be overcome by a canal. Then there would be uninterrupted navigation to Edmonton, 1,000 miles. As an alternative route, there is one which cuts through the heart of Manitoba, but which would involve three or four locks, from the Red River to the Assiniboine as far as Long Lake, thence by dredge channels and locks to Lake Manitoba, one lock across a short neck of land into Lake Winnipegosis, and a dredged channel from Winnipegosis across a marsh into Cedar Lake, an extension of the Saskatchewan. Lake Winnipegosis and Saskatchewan are on the same level. A company is now applying for a charter permitting it to undertake the work. The distance in an air line between Lake Superior and Edmonton is about 1,400 miles. The proposed waterway, following a circuitous route, would be over 300 miles farther than that.

SELECTED FORMULÆ.

Polishing Wax.—To make polishing wax for furniture, says William T. Brannt, melt 8 parts white wax, 2 parts resin, and ½ part Venice turpentine over a moderate fire, and pour the compound while warm into a suitable earthenware pot, and then stir in the oil of turpentine. In twenty-four hours the polish will have assumed the consistency of soft butter, and is then ready for use. Carefully cleanse the furniture with soap water, and when dry apply the polish in a thin layer with a wooden rag, rubbing first gently and then more vigorously. Let the furniture stand for a quarter to half an hour, and rub over more thoroughly with a woolen cloth.

Eucalyptic Shampoo.—

Glycerine of borax	2 ounces.
Esprit menthol	2 "
Solution of ammonia	3 "
Extract of roses	3 "
Fluid extract of quillaja	5 "
Esprit eucalyptus	10 "
French rose water	15 "

Mix. Allow to stand twenty-four hours, then filter.

Cigar Speckling Fluid.—The process of marking artificially on cigar wrappers the light yellow spots, which make cigars so marked preferred by smokers, consists of the application of some active oxidizing agent, such as solution of chlorinated soda, nitric acid in proper dilution, or hydrogen dioxide solution.

We had occasion, says The American Druggist, recently to examine some samples of a liquid and powder used by a firm of cigarmakers to give the wrapper of an inferior tobacco the appearance of the speckled Sumatra leaf, and we found the powder to consist of ammonium carbonate, while the liquid was a fairly concentrated solution of H_2O_2. The mode of using the speckling material is to dissolve one part of the powdered ammonium carbonate in twenty-five parts of the solution of hydrogen dioxide. The spots are then produced by touching the dry leaf with this solution on the end of a pointed stick.

Several patents have been obtained for methods of spotting tobacco leaves artificially, and the following solution is said to be in use by a large firm of cigar manufacturers:

Sodium carbonate	3 parts.
Chlorinated lime	1 "
Water, hot	8 "

Dissolve the washing soda in the hot water, add the chlorinated lime and heat the mixture to the boiling temperature for three minutes. When cool, decant into earthenware or stoneware jugs, cork tightly, and keep in a cool place. The corks of jugs not intended for immediate use should be covered with a piece of bladder or strong parchment paper, and tightly tied down to prevent the escape of gas and consequent weakening of the bleaching powder of the fluid. The prepared liquid is sprinkled on the tobacco, the latter being then exposed to light and air, when, it is said, the disagreeable odor produced soon disappears.

As a matter of information, it may be stated that the speckled appearance of certain tobacco wrappers as they are received in the natural state is due to the work of a species of fungus that attacks the growing tobacco. The tobacco grown on the island of Sumatra in the Dutch East Indies is found very frequently speckled in this way, especially the tobacco which comes from a certain district famed for the fine quality of the leaf. Cigars made from it are much esteemed by smokers who like a mixed cigar.

Malted Drinks.—Many people have an idea that malt is the most wonderful invigorant and tonic in the world. It is of undoubted value under the proper conditions, and it is well to cater to such as wish to take their malt in soda, though the majority of the malt consumed will still continue to be in the form of beer rather than at the soda counter.

MALT WITH COCA.

Fluid extract coca	1 ounce.
Alcohol	1 "
Extract malt to make	4 pints.

MALTED MILK SIRUP.

Malted milk	8 ounces.
Hot water	8 "
Simple sirup	4 pints.

COCA MALT PHOSPHATE.

Extract of malt	2 pounds.
Kola wine sirup	3 pints.
Coca wine sirup	1 "
Cinchona wine sirup	1 "
Pure orange wine	1 "
Spirit of rose	¼ fl. oz.
Acid solution of phosphates	8 "

The kola wine sirup is made by adding 2 pints of kola wine to 3 pints of simple sirup. The coca wine sirup is made by adding 2 pints of coca wine to 3 pints of simple sirup.—American Druggist.

Insecticide for Moths.—

Carbolic acid	10 grammes.
Oil of cloves,	
Oil of lemon,	
Camphor, of each	5 grammes.
Alcohol (90 per cent.)	500 "

Manufacture of Grape Juice and Wine.—Unfermented wine, or grape juice, may be prepared by expressing the juice of ripe grapes and heating it in bottles to a temperature of from 60° to 70° C. for fifteen minutes, the heat rendering the yeast cells and other fermenting agents inactive. The juice can then be kept in well closed bottles for several years without fermenting. To obtain the juice clear it must be filtered, an operation which is easily carried out, as the heating will have coagulated the mucilaginous substances causing turbidity. Filtration may be carried out immediately after heating the juice, or after some time; but in any case the filtered juice must be again heated in bottles to the same temperature originally applied, and then it will keep clear in well closed bottles for several years.—Pharmaceutical Era.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Vienna Export Academy.—Since the 1st of October, 1898, there has existed in Vienna a commercial school of an entirely original organization. This is primarily shown from the fact that the institution is directed by a high official of the Austrian Ministry of Commerce. This direction is not merely nominal, but is evidenced, apart from daily influence on the life of the pupils, by weekly conferences under the chairmanship of the director himself, which have the purpose of receiving from each of the teachers a report of the studies of the past week and those to be taken up in the coming one. Every topic, even in its smallest details, is in direct relation to the object of the institution. This object is the promotion of the Austrian export trade. No serious patron of the academy wishes that the young men, immediately after finishing their studies, should become Austrian exporters. On the contrary—and this is the second original phase of the scheme—it is desired that the graduates, on leaving the academy, act as clerks in exporting and manufacturing firms, there to learn the practice of some special branch of business, whereupon, under further support of the Ministry of Commerce, the graduates are to be placed with larger foreign firms; and finally, by joint protection of the Austrian government, the chambers of commerce, and the particular foreign consulate concerned, they will be aided to establish themselves abroad.

One hears constantly the complaint of Austrian exporters of the sad lack of national commercial representation abroad. It is much more difficult for an Austrian exporter to find in India, China, or South America a market or bank for Austrian wares or drafts than it is for the German merchant, who is naturally preferred by the German firms in foreign countries. Austrian merchants are rarely to be found, even in the most important cities of other lands. This state of things it is now proposed to remedy, by educating ambitious and gifted young men in all the branches necessary for the future exporter to know, and inducing them to adopt such career by the certain prospect of aid from the Austrian government.

The academy has a preparatory course of one year and a regular course of two years. Further, there are special courses of greater or less duration. The tuition fee is 150 florins ($60) a year. The pupils will, besides, be given opportunity to visit occasionally, under the supervision of thoroughly informed teachers as guides, the prominent industrial establishments of all typical export articles, as well as certain commercial cities and ports of special importance. Thus, for instance, an excursion to Hamburg is now planned, while trips to mills, sugar refineries, breweries, and furniture factories have already been undertaken.

The Imperial Royal Commercial Museum, of which the export academy has been made an integral part, has put at the disposition of the academy its library, its valuable trade collections, and the requisite geographical maps and apparatus. The academy has a yearly subvention from the Ministry of Commerce of 20,000 florins ($8,000), and a like sum is being raised by popular subscription.

First of all, graduates of the higher commercial schools are entered as regular students in the academy. Further, pupils are admitted who have passed the grammar schools and possess such knowledge of commercial branches and of the French and English languages as can be acquired in a commercial school of two classes.

All desiring to be admitted as regular students must pass a preliminary examination. In exceptional cases, pupils who have completed their studies in an unusually excellent manner in a commercial school, and can show testimony of already having done praiseworthy work of a practical kind, may be admitted as regular students by the faculty, without preliminary examination. This rule of exception has already been applied in many instances, and gives the academy some of its most promising pupils. Two groups of students can be plainly distinguished—those with and those without practical experience. The academy would perhaps attain its highest plane if only students who have had practical experience were admitted.

In no class of the academy are more than thirty students admitted, and only twenty in the preparatory course. The actual number of pupils at present is near the maximum allowed.

Attendance at the classes and lectures of the export academy is compulsory and subject to strict supervision. An absence of eight days without proper justification is followed by striking off the student's name from the roll. This is another distinguishing feature of the school, wherein it differs from all other Austrian and German high schools and recalls the Paris École des hautes Études, as well as French schools in general.

At Christmas and Easter during every year, oral examinations are held in all the branches of study. During the first year, the annual examination takes place in the first half of July.

By reason of a special order of examination, the regular students have to undergo a severe final examination at the close of the second year, before a board of examiners presided over by a representative of the Ministry of Commerce. The names of students who do not pass one oral examination without good excuse are stricken from the rolls. In some cases, the board of examiners may permit the repetition of a year's course, or of the severe final examination.

Only those students are admitted to the second year who have favorably passed the annual examination in all branches of the first year's course.

There are thirty-four hours weekly in the preparatory course, and in the first year thirty-four or thirty-five obligatory hours every week, besides some that are not obligatory. The preparatory course has for its purpose to advance graduates of gymnasia and "real" schools about as far in one year as an ordinary commercial school does the undergraduate in two or three years.

Of the two yearly courses of the academy, only the first has so far been opened, and the students have in all the examinations up to now given brilliant evidence of the excellent curriculum. In this course, great stress is laid on the study of the French and English languages, with practice in correspondence (six hours each weekly). Four hours a week are devoted to domestic and foreign law, so far as it concerns commerce. Three hours are given to practical exercises in the office work of export, import, and factory businesses. Instruction in this important branch is intrusted to the vice-director of the academy. The limited time given to this work, "muster comptoir," is only the natural consequence of the fact that all students must be familiar with the principles of office work before their admission.

In view of the burden entailed by the large number of school hours, home time is demanded only for languages and office lessons. Instruction in economics, with special regard to tariffs, in the usages of export trade, in commercial geography, and in knowledge of the world's wares according to kind and production is imparted in so-called seminaries—that is, institutions which afford immediate practice of what has been learned from the teacher's lecture, and, as far as possible, actual inspection of the modes of production and of samples. This experiment of giving the pupil the most important facts right in the school, instead of letting him learn by heart what he is sure to forget speedily, and to have him practice it on the spot until indelibly engraved on his memory, is one of the most daring as well as important innovations in the field of pedagogics, and deserves to be propagated.

Besides all this, lectures on selected subjects of actual interest are given by the professors of the export academy, by manufacturers in the various industries, and by ministerial officials, and are attended voluntarily by the students, who display deep interest in them. In this manner they become acquainted with special questions of the day that are engrossing public interest, in a manner that is unbiased by party standpoints.

I had the pleasure of observing the practical working of this feature of the academy, in a lecture which was a comprehensive description of the world's commercial institutions devoted to the export trade. The lecturer spoke, in particular, with great admiration and thorough knowledge of the Philadelphia Commercial Museum and the National Association of Manufacturers, as well as of our other export associations. About the lecture room was displayed printed matter bearing on the subject. In the American exhibit I noticed a copy of the tariff, consular invoice certificates, consular reports, the newly issued American Trade Index of the National Association, a copy of American Trade, and a number of other publications.

This export academy should be of special interest for us in the United States. The addition of a similar school to the excellent means for information at the command of the Commercial Museum, in Philadelphia, might cause young men to be of great use in our export trade and achieve even better results than the academy here, which is proving so practical a measure. Such a school would be of untold benefit to our national commerce, if attended for a year by men about to enter our consular service. It would be an ideal consular training academy.

CARL BAILEY HURST, Consul-General, Vienna.

Breweries in Jamaica.—Under date of April 29, 1899, Consul Dent, of Kingston, writes to a Chicago correspondent as follows:

There are no breweries, as we know them at home, in the island of Jamaica. One was established in Kingston in 1890, with a complete plant, and, after being in operation less than two years, failed. Since then, a number of so-called breweries have been started. Their process is the simple one of fermentation in several casks (three or four) of 50 or 100 gallons each. Last year, an attempt was made to form a stock company and start a brewery on a large scale, but this met with failure also. Barley pays a duty here of 8 cents per bushel. All malt and malt liquors pay a duty of 18 cents per gallon. The importations of ale and beer last year amounted to $156,000. There might be room here for a practical brewery.

Wheat for Alimentary Pastes in France.—In several European countries, the different forms of edible pastes known as macaroni, spaghetti, vermicelli, nouilles, etc., are produced in very large quantities. From a small and somewhat local business it has become a large, prosperous, and constantly increasing industry, upon which millions of people depend for their food. As this increase has created a state of affairs which may become of direct advantage to the agricultural and exporting interests of the United States, it is worthy of the attention I give it in this report, say U. S. Consul Covert, of Lyons.

The manufacture of these preparations of flour was first carried on in a small way in Sicily and southern Calabria, and then on a much larger scale in Naples. In the enterprising business center of Genoa it became a staple article of trade, and an improvement in quality was followed by a rapid increase in demand. At Marseilles, the different branches of the industry were specialized. There the selection, purchase, and preparation of the proper kind of wheat for paste making became a distinct trade, or rather constituted a separate branch of commerce and manufacture. Certain men made a business of buying the wheat, of grinding it into the sort of "grists" or "semoule" which is used for making edible pastes, and of selling the semoule to the paste makers and the by-products of the wheat to other customers. There are now importers and brokers in these special kinds of wheat, grinders of the semoule, and a class that sells the semoule to paste makers. It has thus become easy for manufacturers to obtain the precise quality of wheat desired for the different pastes. A number of establishments are constantly employed in making large hydraulic presses for the production of these pastes, and the industry is carried on extensively in France, Italy, Germany, Switzerland, and some other countries.

It is estimated that the French output of these pastes is from 120,000,000 to 170,000,000 pounds per annum, and this product is unquestionably destined to increase greatly. To Americans it may seem strange that the power to purchase wheat foods is only now becoming general in most of the civilized countries. Thirty years ago, black rye bread was universally consumed by the working classes and the peasantry in France. Bakers tell me that they all sold rye bread up to about 1870; now, it is rarely found in any bakery and is eaten only in the country. The president of the millers' syndicate of this city tells me that the masses of the French people want white wheat bread and the best of it. The president of a British economic association stated last autumn that the wheat eaters of the world were 371,000,000 in 1871 and 516,000,000 in 1898, an increase of 145,000,000. Every great railroad opened adds to the number of wheat eaters.

As the use of wheat has become more general and the power to pay for it has grown correspondingly, it is but natural that a strong tendency to seek variety in its preparation for food should exist. Again, when vegetables are scarce, as is frequently the case in winter, there will be an increased demand for the food products of flour. The new and better methods for the manufacture of the edible pastes, the knowledge of just the kind of pastes certain classes of wheat will produce, and the improvements in the heating and drying processes are coincident with the sudden and widespread increase in the use of wheat foods. The continued growth of this industry will depend upon the supply of special kinds of wheat, for a decline in consumption would immediately follow any attempt to manufacture pastes of ordinary wheat.

Paste makers are unanimous in the opinion that American wheats will not answer their purposes; but, when one considers the almost endless variety of our soil and climate, it seems that some locality must be found where a suitable wheat can be grown.

What is wanted is a hard wheat, containing a large percentage of gluten and a relatively small percentage of starch. Our wheat is lacking in both these desiderata. But all gluten is not alike. Some chemists tell me that the excellence of the gluten depends upon the relative quantities of two substances which they have extracted from it, to wit, gliadin and glutenine. They have formulated rules and methods for the study of this question, which will no doubt be of service to those who wish to follow it up. It may be, however, that the quality of gluten depends upon some other elements. But there is a tendency to attribute excellence of gluten to a proper proportion of gliadin and glutenine.

An American chemist, Mr. Edwin W. Serrel, now living near Lyons, has carefully investigated this subject and informs me that the wheat which is now considered the best is that grown in the neighborhood of Taganrog, Russia; the next is from Algeria. That produced in southern Italy, where the manufacture of pastes originated, has lost the high place it formerly held. The best wheat grown in France—considered better than the American product—is from the neighborhood of Clermont-Ferrand.

Rapidity of growth and ripening is considered of prime importance in the production of the desired qualities in the wheat. These are the chief factors in the Taganrog product. If our farmers could produce such a wheat, it would find more uses than in the pâtes alimentaires above referred to. There would be an excellent market in years of drought in Russia.

Millers and bakers in France have found that bread is improved by putting into it a larger amount of gluten than is found in French or American wheats, and as a consequence very hard wheats, the Taganrog, generally, are mixed with the others. These wheats cannot be raised in France, but must be imported, and they are the only kinds which are always sure to find a market in this country, as the French farming community will always demand and are politically strong enough to secure a high protective tariff on wheat and other grain.

The great development of American exports and the enormous trade balances in favor of the United States are at this moment exciting the utmost alarm, and it is possible that American producers may be compelled to fight increased efforts to bring about a more even balance of trade. If it be remembered that the French people eat more bread than any people in the world; that, generally, France needs very little ordinary wheat, but that she always will need a very considerable percentage of hard wheat ("hard" is not understood in the American sense in France), it will at once be seen that there is a possibility of finding a large opening for American agricultural products in this country, not to speak of the great consumption of hard wheat in such macaroni and spaghetti eating countries as Italy and Spain.

Moreover, as the experience of the French has proved that an admixture of hard wheat, in small quantities, improves the quality of the bread, it is reasonable to infer that this practice will extend to other countries, further enlarging the market for hard wheats. The authority quoted above expresses the opinion, after a long study of the varied climate of the United States, that all hard wheats can be produced there, if the matter receive the proper attention. These wheats are now grown to a certain extent in Tunis, Algeria, India, and Canada, as well as in Russia. Very little, however, reaches this country from Canada.

Glove Manufacture in Germany.—Consul Erdman writes from Breslau, under date of April 29, 1899:

The export of kid gloves from this consular district has amounted to $736,587.67 per annum. The glove leather is tanned, dyed, and the gloves are cut at the factories here; but most of them are sewed by girls in Austria, especially in Bohemia. German girls have never been taught the art. There is now an arrangement by which free sewing schools will be started by the Prussian government, one to be located in the province of Silesia and the other in the Rhine Province, where are located most of the glove factories, the sewing for which has been done in Belgium.

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No. 438, May 29.—*Wheat for Alimentary Pastes in France—*French Trade with Cuba and Puerto Rico—*Breweries in Jamaica—*Glove Manufacture in Germany.

No. 439. May 31.—Trade of Vladivostock.

No. 440. June 1.—*The Vienna Export Academy—Germany's Trade with Switzerland—*Germany's Merchant Marine—Revised Regulations for Automobiles in France—Artificial Cotton in Austria—*Trade with Turkey.

No. 441. June 2.—Germany's Beet Sugar Industry from 1877 to 1899.

No. 442. June 3.—Mining and Trade in British Columbia—Pearl Fisheries of Dutch East India.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

THE WHITE MINERAL PRESS.

EVER since it was found that bricks and briquettes of concentrates, calcines, flue dust, and the like, when used in the smelter or blast furnace, increased the capacity of the furnace, improved its action, and effected a material saving in power, manufacturers have turned their attention to the making of special machinery by means of which the materials could be compressed far more economically and efficiently than was possible when the briquette was first introduced. Perhaps the most improved form of briquetting machinery which has yet been devised is to be found in the White mineral press, made by the Chisholm, Boyd & White Company, of Chicago, Ill.

The machine in question consists of a large chasing-mill, in which two heavy rollers follow each other in a circular track or pan bottom. At one side this track is cut out to admit a perforated circular disk, whose center is outside the rim or curb of the mill, and whose top surface is level with the pan-track. A segment of the disk thus forms part of the track over which the rollers travel. The pan rests upon a heavy iron base forming a support for that part of the mold disk within the pan.

The mold disk in the standard machine is 5 feet in diameter and 2¼ inches in thickness, and has two circles near its outer edge, each containing twenty-four molds. Each roller weighs 5,000 pounds, is 48 inches in diameter, and has a chilled iron ring with a 12-inch face. The pan is lined with removable chilled iron plates, forming the track for the rollers. Each roller is driven by a crank-shaped steel shaft which permits free vertical action of the roller while preventing lateral motion, and which maintains the roller in vertical position. The inner end of each crank shaft has a long horizontal bearing in the cross-beam. The outer end is provided with a 10-inch hard bronze washer, which is recessed into the roller, and which takes the thrust due to the centrifugal action of the roller.

The center sleeve rises cone-shaped 15 inches above the pan and extends 12 inches below. The sleeve provides a bearing 28 inches long for the main spindle. The cross-beam is keyed to the main spindle, is supported by a bearing on the top of the center sleeve, and extends nearly to the rim of the pan, vertical holes being provided to admit four plow-holders.

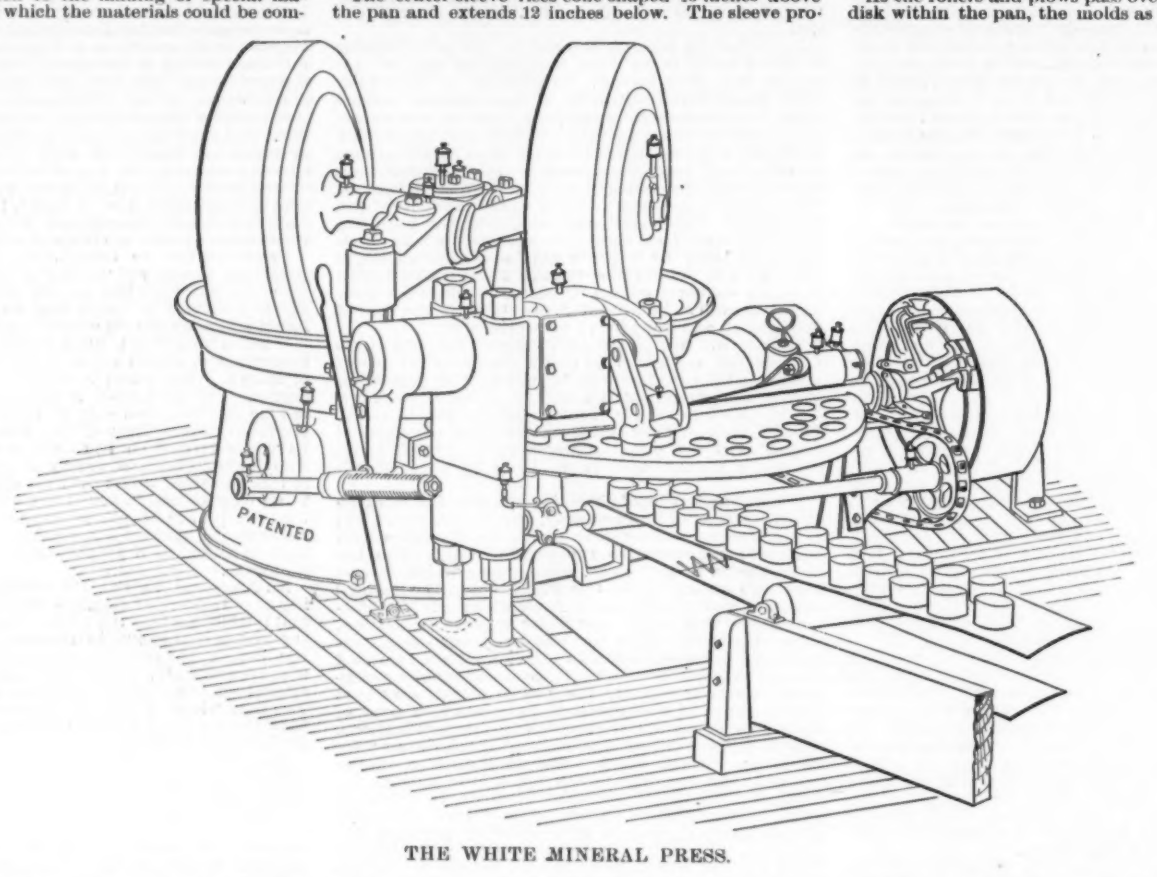
This construction is peculiar in so far as the rollers when in motion carry the weight of the cross-beam, spindle, and gear to such an extent that there is but little downward pressure on the bearings under the cross-beam. The outward thrust from the centrifugal action of the rollers is counter-acted by their tracking inward.

The movement of the disk is effected by an arm called the feed-arm, which is journaled at the center of the disk, the outer end being attached to a pitman connected with a crank-gear. The arm is provided with a round steel pawl which drops into one of the holes and pulls the disk around 15 degrees when acted upon by the crank-gear.

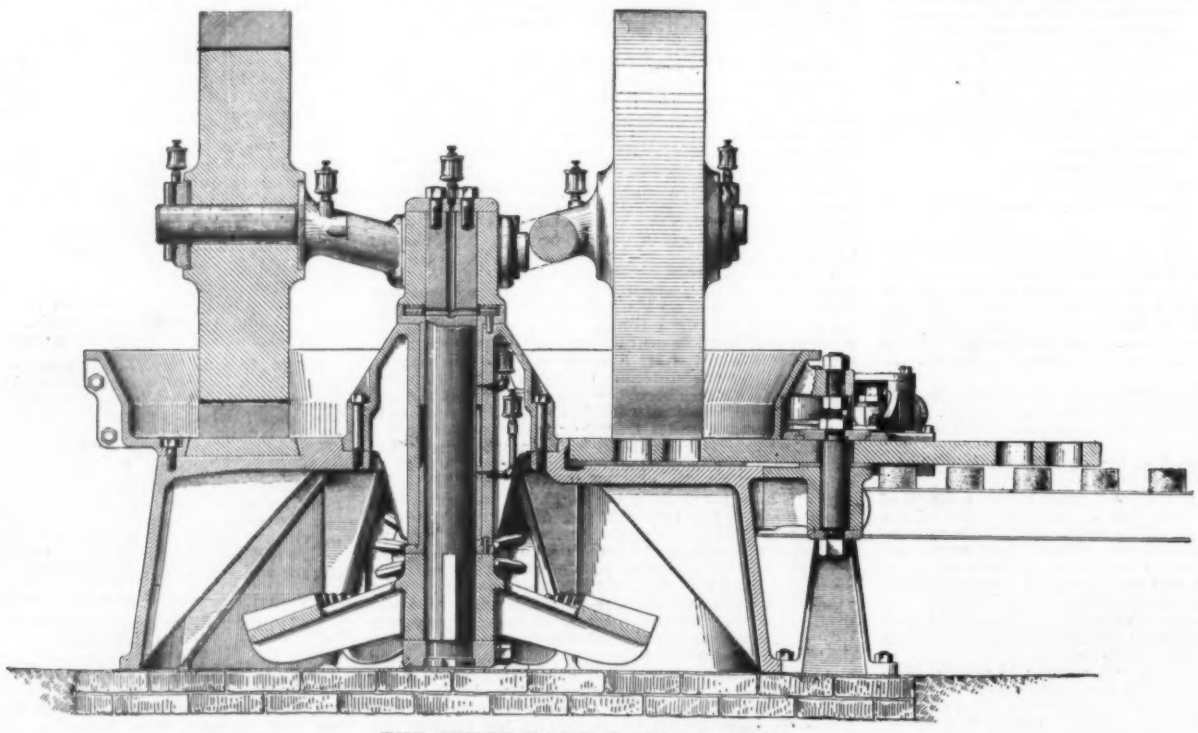
The repress is firmly secured to the pan frame or base. The upper and lower press frames are held centrally to the spindle, and between them the disk passes. When the disk is at rest, the plungers or dies are forced into the molds by a toggle-lever located within the upper press frame. The ejecting plungers at the same time enter the molds and force the finished briquettes upon the delivery belt. The materials to be briquetted may be bedded in the ordinary way, the bed being regularly shoveled into the machine. The plows and rollers thoroughly knead and mix the lime and non-plastic particles.

As the rollers and plows pass over that section of the disk within the pan, the molds as they work from left to right are subjected to repeated fillings and pressures as each of the ponderous rollers with its peculiar twisting and grinding action travels or rolls over them at the rate of twenty or more times per minute.

Each successive pair of molds in passing out at the left, evenly filled with solid briquettes, stops directly under the plungers of the repress, where the finishing pressure is applied. The action of the plungers is accurately timed with the disk so that the latter is free to move with the forward travel of the feed-arm. The feed may be continuous or intermittent. The blocks produced are uniform in size and in density.



THE WHITE MINERAL PRESS.



THE WHITE MINERAL PRESS—SECTION.

MOUNTAIN WATER COURSES AS INDUSTRIAL AIDS.

CONSUL Monaghan, of Chemnitz, commenting upon Germany's desire to utilize every means of industrial development, quotes the following from a lecture delivered at a congress of physicists at Düsseldorf:

"In recent times, two factors have attracted special attention to mountain streams and their practical value. Now that all navigable rivers in Germany have been regulated, their high waters, once fraught with

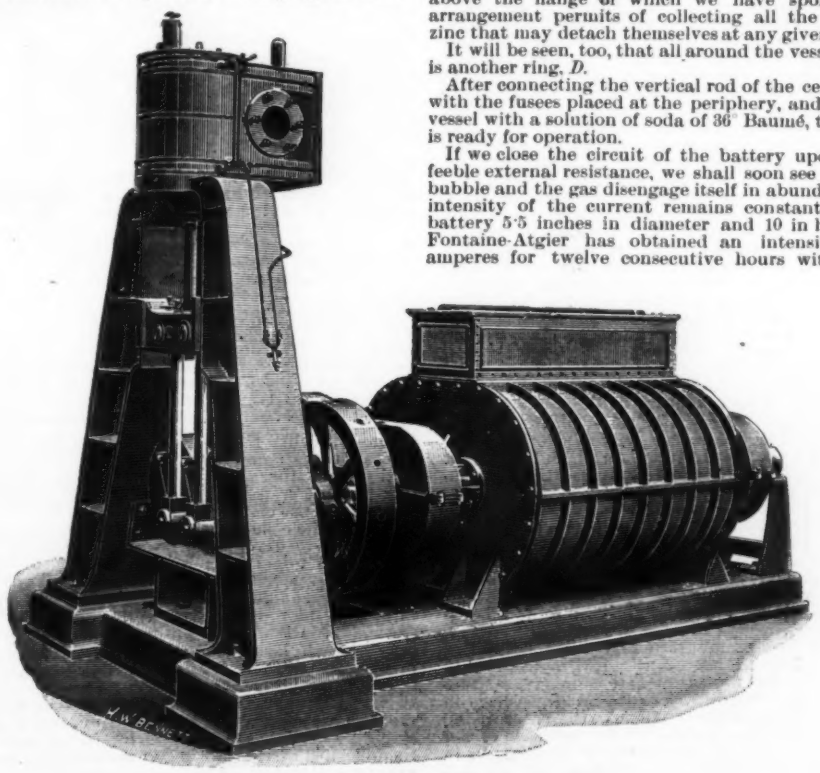
deplorable consequences to the inhabitants of low lands, practically confined, the question has arisen how far the courses of streams in the mountainous districts may be utilized for industrial purposes. There has been a marked increase in the value of water power since it has been proved that it can be made available by electrical transmission for works at long distances. The electrical exposition of Frankfort in 1891 showed that 75 per cent. of the power found at a river could be carried a distance of 177 kilometers (110 miles). At that time, the cost of the experiment was too high to make it practicable. Since then, many methods of transferring the power 20 to 30 miles have been made profitable. Inasmuch as the danger due to the movements of large volumes of water in the mountains must first be done away with, the employment of such methods has been restricted hitherto to plants where the lowest water level of the rivers was sufficient. There will be vast progress in utilizing water power as soon as this difficulty is overcome—i. e., the waters of the mountains will be utilized equally during the whole year.

"The dangers hitherto inseparable from waters in the hills can be scientifically controlled. One has only to construct reservoirs large and secure enough to contain easily more than the largest probable amount and to give it off in the dry seasons in the required quantities. How far such reservoirs endanger the inhabitants of the valleys is a question much more important than all those concerned with industrial or agricultural development. Only after the most careful scientific investigation by the country's best engineers should the basins be built or the valleys dammed. The appalling accidents like the Johnstown disaster and the more recent one in France have prejudiced the public mind. Dams do not, however, burst when properly built; and to build dams properly is no harder, nor half as hard, as to swing bridges across broad spans of rivers and guarantee them against storms. Water volumes may be estimated to a maximum; winds and storms, with free play of the elements in wide areas of space, never.

"The advantages of storing up the water may be summarized as follows: Creation of a uniform water power for the factories in the valley, and inducements to increase said industries; distribution of power by electrical transmission; a higher water level in the streams, even in the warm summer months, and a decrease of their impurities; decrease in the liability of the rivers to freeze by the drawing off of comparatively warm water, as the layers of water in a reservoir are rarely less than 5° C.; improvement of the water supply for cities and irrigation of barren lands; decrease in the liability of floods and the damages done by them; decrease of the desire on the part of the inhabitants to collect in large towns; beautifying the landscapes, developing fisheries, water and ice sports, etc., and improvement of means of transportation."

COMBINED ENGINE AND BLOWER.

THE blower and engine which we illustrate herewith has been specially designed to the order of the East Indian Railway directors for their extensive shops in India. The engine is of the duplex type, with two connecting rods, each driving its own crank disk, the two rods being coupled to one crosshead in common. The slide valve is worked diagonally from one blower shaft, a system largely adopted by the makers, Messrs. Alldays & Onions, Pneumatic Engineering Company, Limited, of Birmingham. The engine has a cylinder 18 inches in diameter, with stroke of 19 inches, and is designed to work at 250 revolutions per minute, with a boiler pressure of 80 lb. per square inch. When working under full load it is capable of developing 160 horse



COMBINED ENGINE AND BLOWER.

power. The blower itself, when being driven at the above speed, will deliver the enormous output of 1,200,000 cubic feet of air per hour. Its total length over all is 17 feet 4 inches, and height 12 feet 10 inches, the blower itself 6 feet 3 inches in length. The whole machine complete weighs over 20 tons. The makers have constructed two of these blowers. We are indebted to London Engineering for the engraving and article.

A NEW BATTERY.

A FEW years ago, electric batteries were the object of numerous special studies, but for some time past these seem to have come to a complete standstill. Dr. Fontaine-Atgier, who has heretofore occupied himself with various other electric questions, has recently made a few new and interesting observations upon the one under consideration, and has also been led to construct a new battery, which we propose to describe.

In the first place, he has brought into prominence the property possessed by wire cloth (principally in the form of cylinders of a certain bulk) of being energetic depolarizers of batteries. In No. 1 of the accompanying figure is given a general view of a battery into the construction of which this material enters, and in No. 2 are shown the details of the pieces that form it. The external vessel, *E*, is of galvanized iron. All around are suspended, through hooks, small cylinders, *G*, formed of a roll of wire cloth, and designated by the name of "fusees." All these cylinders are kept in place by a ring, *F*, placed at the top and in the interior of the vessel.

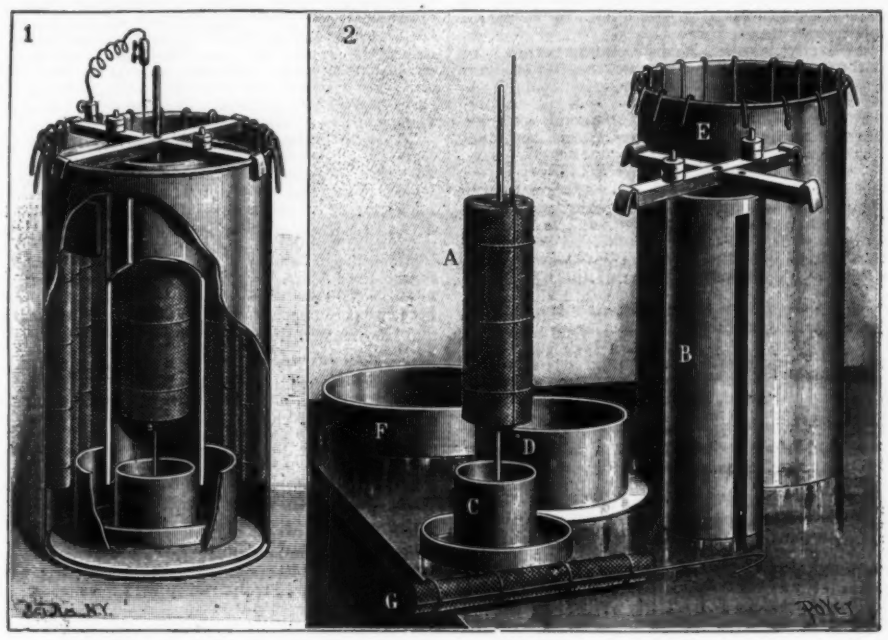
In the center of the battery is fixed the zinc, which is held by two small bars arranged at right angles. Finally, in the interior of the zinc, a fusee, *A*, similar to the preceding, but more bulky, is mounted upon a central rod that rests in the interior of a small vessel, *C*, provided with an external flange. From No. 1 of the figure, it will be seen that this small vessel is placed beneath the central fusee. The zinc is suspended above the flange of which we have spoken. This arrangement permits of collecting all the debris of zinc that may detach themselves at any given moment.

It will be seen, too, that all around the vessel, *C*, there is another ring, *D*.

After connecting the vertical rod of the central fusee with the fusees placed at the periphery, and filling the vessel with a solution of soda of 36° Baumé, the battery is ready for operation.

If we close the circuit of the battery upon quite a feeble external resistance, we shall soon see the liquid bubble and the gas disengage itself in abundance. The intensity of the current remains constant. With a battery 5·5 inches in diameter and 10 in height, Dr. Fontaine-Atgier has obtained an intensity of 2·5 amperes for twelve consecutive hours without any variation. The consumption of zinc during the experiments did not exceed 20 grains per ampere hour. Such results seem to prove that the wire cloth effectively plays the part of a depolarizer. It offers an easy passage to the hydrogen gas in measure as it forms, and the latter escapes to the exterior in bubbling.

All the observations made by Dr. Fontaine-Atgier have been confirmed by the Central Laboratory of Electricity, which placed two different models of the battery upon trial. The first of these, which was like the one that we have just described, gave an uninterrupted discharge for 12 consecutive hours upon a resistance of one-tenth of an ohm. The electromotive force was 0·45 volt, the initial difference of potential 0·32 volt, and the mean intensity 1·9 amperes. At the beginning of the experiment, the intensity was 3·3 amperes, and at the end 1·71. The internal resistance was 0·2 ohm. The capacity of this battery was 130·57 amperes-hour and the consumption of zinc 19 grains per ampere-hour. With the liquid, its weight was 13 pounds. A second model of the battery, which



DR. FONTAINE-ATGIER'S NEW ELECTRIC BATTERY.

was similar, but formed of wire cloth covered with granulated manganese, furnished 70 hours of work. The electromotive force was 1·54 volts, and the initial difference of potential 0·9 volt. The intensity, which was 9 amperes at the beginning, was but 5 during the three following hours, and diminished progressively until it reached 1·06 amperes only at the end of the experiment. The internal resistance was 0·04 ohm, and the capacity 121·13 amperes-hour. The wear of the zinc per ampere-hour was, as before, 19 grains.

In another model of the battery, exclusively composed of wire cloth, Dr. Fontaine-Atgier substitutes for the peripheric fusees a drum formed simply of a band of wire wound spirally. In pursuing his researches, the inventor had an opportunity of making a few observations which it is of interest to mention. In the first place, he remarked that between two masses of wire cloth of the same metal, of unequal surfaces, immersed in the same exciting liquid, there is established a feeble difference of potential that varies from simple to double, according as the zinc is or is not in the element.

Finally, wire cloth submitted to a charging current preserves the charge, and is capable of playing the part of an accumulator. Dr. Fontaine-Atgier is now pursuing his studies in this direction. According to the first results obtained, it is certain that this new battery offers great advantages. It is especially distinguished by the constancy of the current, which it furnishes for a very long time, after a few variations at the beginning of its operation. The objection may be made to it that it has a feeble electromotive force; but the inventor, promises us an improvement in this respect.

For the above particulars and the illustration we are indebted to La Nature.

[Continued from SUPPLEMENT, No. 1223, page 19609.]

THE COMMERCIAL DEVELOPMENT OF GERMANY.*

By C. ROZENRAAD, F.S.S.

IN view of all these important results, one cannot help deploring the tendency in the German Parliament, and also among several industrial firms, toward protectionism, which leads them to form syndicates, even in articles of first necessity—for instance, in coals, for which a powerful syndicate has been formed in Westphalia, with a view to control the market and raise prices at every opportunity, or whenever foreign competition is not felt. But these reprehensible maneuvers have met with the retribution they justly deserved. The manufacturers of Twenthe, the Lancashire of Holland, resenting the often arbitrary increase in price of Westphalian coal, have decided once for all to shake off the yoke of the above syndicate by acquiring coal mines in Preston, and forming, at Newcastle-on-Tyne, the Preston Coal Company, Limited, with a capital of £650,000. This company will work the mines and dispose of the coal principally in Holland. The loss of such an important and regular customer as Twenthe is, naturally very detrimental to the interests of the syndicate, but the sharp rebuke thus inflicted by the friends of free trade on the knights of protectionism is well deserved, and has had the result of benefiting England, and of drawing still closer the already excellent commercial relations between the two sole champions of free trade in Europe, England and Holland.

But whatever may be said against the formation of syndicates in articles of first necessity, the development of German trade is undeniable, and the result obtained is not only a brilliant proof of the activity of the Ger-

* A paper read before the Society of Arts, London, March 21, 1899.

man nation, but it also shows how Germany has been well advised in renouncing the ultra-protectionism of Bismarck during the last few years of his government, and following a more moderate commercial policy. A country such as Germany, whose annual exports exceed £200,000,000, cannot be exposed to frequent modifications in foreign tariffs. It must have stability, at least, for some years in the custom duties, and be sure that the different markets do not escape them. Therefore, Germany acted in its own interest by concluding the different treaties of commerce mentioned before. But, as in the time of the Hanseatic League, the protectionists, far from acknowledging how much a more moderate commercial policy has contributed to the development of German commerce, are continually on the alert, trying, at every opportunity, to influence public opinion toward protectionism. And this in view of the decision which must be taken before long on the subject of the renewal of the treaties of commerce signed in 1892. It is to be foreseen that the attempts of the Agrarians will give rise to lively discussions in Parliament, but no doubt the good sense of the German nation will finally prevail, and the continuation of a commercial policy so beneficial to Germany will be insisted upon. England has every interest in watching the agitations of the Agrarian party, which favors extreme protectionism, not only because if, against all expectations, the Agrarians succeeded, the development of German international commerce would be checked, but also because the treaty of commerce of May 30, 1865, between England and Germany, has really ceased to be operative since July 31, 1898, it having been denounced by England on July 30, 1897, in support of the commercial policy inaugurated in April, 1897, by Canada. As you are aware, the Canadian Parliament passed a bill providing for the following reductions on import duties: From the passing of the bill until June 30, 1898, a reduction of 12½ per cent. and from July 1, 1898, a reduction of 25 per cent. on goods, with but few stated exceptions, imported into Canada from any country whose tariff admits the products of Canada on terms, on the whole, as favorable to Canada as the terms of the present reduced tariff.

It followed that, as Great Britain admits Canadian goods free, the reduction applied automatically to imports into Canada from the mother country. But the commercial treaties concluded by Great Britain in 1862 with Belgium, and in 1865 with Prussia and the Zollverein, stipulate that goods imported from Belgium and Germany into the British colonies shall not be subject to higher or other duties than goods imported into the said colonies from Great Britain. The question arose, therefore, whether owing to these stipulations the reductions in the Canadian tariff should not at once apply to imports from Belgium and Germany, without any corresponding reduction on their part of the duties at present imposed on imports from Canada.

In order to remove all misunderstanding, England denounced the said treaties as from July 31, 1898. But while, by this measure, every obstacle was removed which heretofore prevented the English colonies from freely adopting whatever fiscal treatment they might choose to apply to imports from the mother country, the commercial relations between England and Germany would have become, from July 31, 1898, uncontrolled by treaty. This, in view of the important commercial relations existing between the two countries, would have been detrimental to both of them.

This side of the question did not escape the governments of the two countries, and as there was scarcely time to arrive at a final understanding on the subject of a new treaty of commerce, it was stipulated on June 11, 1898, that, while continuing negotiations in favor of a new treaty of commerce, Germany would grant up to July 30, 1899, to England, all the advantages which are granted by the German empire to the subjects and products of the most favored nation, while Germany is at present, in Great Britain, and in all British possessions (with the exception of Canada), subjected to the lowest customs tariff rates.

In a word, a prolongation of the treaty of 1865 is temporarily secured, and, until a final treaty is concluded, it will be well to take into account the protectionist tendency of a great number of the members of the German Parliament, although as I have said before there is no doubt that, in view of the conciliatory and open spirit which underlies the relations of the governments of the two nations, a final understanding will be arrived at on the existing basis, and this time we hope not for a short period. Germany has every interest to come to an understanding, as England is one of Germany's best clients, buying much more from Germany than Germany does from England.

In 1895, Germany exported to England only £27,000,000; in 1896, £27,600,000; in 1897, £26,000,000; and in 1898, over £28,500,000; while England exported to Germany, £20,500,000 in 1895, £22,200,000 in 1896, £21,600,000 in 1897, and £22,500,000 in 1898.

Taking these figures alone, it would appear that England is constantly a debtor to Germany, but we enter here on a question very difficult to solve—the balance of trade. Nothing is so difficult as to strike this balance. To come to a right conclusion, the figures of imports and exports are not conclusive. The bank commissions, interests, insurance premiums, freights, arbitrage in foreign stocks, coupons, and many other statistics must be taken into account. These are uncertain quantities, and make it difficult to arrive at anything like reliable results.

The only barometer which, to a certain extent, can guide us on this subject is, and will always be, the rate of exchange, and it is certainly remarkable that, notwithstanding the above figures, and the fact that the rate of discount of the Imperial Bank of Germany and that of the open market have been, in 1898, nearly constantly above the official and market rate in London, the rate of exchange on London in Berlin has neither in 1898, nor in 1899, gone down, one single day, to the point at which it would have been possible to send, with profit, gold from England to Germany. On the contrary, the rate of exchange on London in Berlin has several times even reached a point at which gold exports from Germany to England would have been possible. In January, 1898, the lowest quotation (for eight days) of the rate of exchange on London in Berlin was 20·375; in February, 20·42; in March, 20·45; in April, 20·49; in May, 20·445. During the latter two months the rate of exchange even reached the point for the export of gold from Berlin to London, the highest quotation being 20·53 and 20·53½; in June the quotation was again 20·375; in July, 20·37; in August, 20·395; in September, 20·30; in October, 20·37; in November and December, 20·40. At no time, therefore, did the rate of exchange permit of the export, with profit, of gold to Berlin, although several times Germany sold large amounts of foreign securities, notably Italian stocks, mostly purchased by France on the signing of the treaty of commerce with Italy, sales which were settled principally in the international valuta par excellence, bills and cheques on London.

The continuance of a rate of exchange adverse to Germany may be partly due to the fact that the Deutsch-Asiatische Bank, representing the leading German banks, took up one-half of the 4½ per cent. Chinese loan of £16,000,000 (the other half being taken up by the Hong-Kong and Shanghai Banking Corporation), and partly to larger imports of food stuffs, to meet the wants of the ever-increasing German population, and of raw materials to cope with the great development of industry.

As we have seen above, the total imports for 1898 attained the imposing figure of £273,882,400 (5,477,648,000 marks), exceeding the exports (£200,087,300, or 4,001,746,000 marks) by £73,795,100 (1,475,902,000 marks).

This great excess of imports over exports should not give rise to any surprise or uneasiness. Just as the millions and millions of pounds received by England for freights, interests, commissions, and for the construction of ships for foreign account, etc., enable her to make up the difference between the exports and imports, and to pay for the food she must import for her population, and for the raw materials used in her home industry, so Germany also receives with her extensive shipping, banking, and industrial business, large remittances from abroad in the form of freights, commissions, interests, etc. The money spent by the foreigners who frequent her watering places or study at her universities is also an important item. Besides, the interest and dividends on the many millions of foreign securities held in Germany must also be taken into account.

There is not, therefore, the slightest reason for alarm. The situation of England and Germany is, on this point, identical and perfectly safe, on condition, of course, that they continue to increase their national labor, and neglect nothing to increase their exports. To-day China must emerge from its Eastern lethargy, and will have to answer the call of Europe, inviting her to open the country to progress and civilization. To-day Africa is yielding more and more her treasures to energetic and enterprising countries, England and Germany. These two great commercial nations have, in those regions, a vast field for their activity and energy, and enough to occupy their industry and commerce for many years; and far from competing with each other, the governments of the two nations have found, and, no doubt, will find in the future, many opportunities to work together, in perfect agreement, in the interest of their commerce, and in the interest of peace, justice, and civilization. Germany agrees entirely with the policy of England, who, concentrating her efforts to maintain her own trade, claims only to share in any advantage obtained by any other nation, just as any other nation is free to share in any advantage obtained by England. This policy of England, equitable and just and of a nature to give great results, corresponds entirely with Germany's own views.

The German government is, therefore, giving its entire support to the policy followed by England in the far East, where the bay of Kiao-Chau was occupied after the murder of the German missionaries in the province of Shantung, and a squadron sent, under the command of Prince Henry; and, as we have seen above, half of the Chinese loan of £16,000,000 was taken with England. In a word, Germany has seen the wisdom of securing, in the interest of her commerce and industry, a firm footing in China and of maintaining and enlarging her influence in those regions. German industry requires the Chinese markets all the more, now that the United States, who formerly were such good clients of Germany,* not only manufacture more and more themselves all they require, but even compete relentlessly with Germany in all the markets of the far East. According to a recent report of the French commercial mission sent to China in 1895 to study the commercial and industrial situation, German commerce in China has developed during the last four years 70 per cent. In 1892, 78 German firms established themselves in China; in 1897 there were 104. As everywhere else, so in China, England has the lion's share of the trade, but Germany follows immediately, coming even before Japan. In 1897 German exports to China amounted to £2,312,500 (46,500,000 of marks), while English exports to China in the same year were £5,142,000, and in 1898, £5,044,000.

Besides, as has been recently stated in the German Parliament by Herr von Bulow, Secretary of State for Foreign Affairs, the German empire, which has a right to railways and mining concessions in Shantung, intends to build a railway between Kiao-Chau and the Hoang-Ho. In connection with the construction of railways, a contract was about to be concluded between the German empire and a syndicate of the leading German East Asiatic houses for the formation of a joint stock company with its seat at Tsintau and a capital of over fifty million marks. In the event of the profits being sufficient, the German empire would participate in them.

Everything shows that Germany, which, as well as England and France, has sent, in 1897, a mission to China, to study the industrial and commercial situation of that country, will try to take a large share in the trade of the far East. Thanks to the enterprising spirit of her children, thanks to the tenacity of her efforts, Germany has already made great progress in this direction, and everything indicates that she will try in the interest of her commerce and industry to extend her operations in these countries where there is yet so much to be done, where there is room for every one. During the last thirty years Germany has spared no effort to increase her production, which exceeds now the amount she can absorb herself, and, therefore, she is obliged to find new markets.

But to protect these markets, to give courage and energy, to defend eventually the interests of those of her sons who in these distant lands work to extend national commerce, a powerful navy is necessary, and Germany neglects nothing in that direction. Especially the Emperor William has devoted all his energy, talent, and firmness to endow Germany with a strong navy. The struggle in this direction with the German Parliament never discouraged him, nor turned him from his design, and whatever obstacle arises will be overcome by the energetic efforts of the man who wishes the commercial greatness of his country, who sees to what extent Germany has already succeeded, and who feels what an immense future is in store for her.

This is clearly shown by his speech delivered at Kiel on December 16, 1897, when his brother Henry was starting for China at the head of the German squadron, when he said:

"Under the protecting banner of our German ships of war, our commerce, the German merchant and German vessels must now obtain those rights which the foreigner concedes to all nations. Our commerce is indeed no new creation. The Hanseatic League was in olden times one of the mightiest enterprises that the world ever saw. The German towns were once able to fit out fleets such as had never been seen before. But the league decayed, and inevitably declined, because one of the two conditions of its maintenance was lacking—the imperial protection. The first preliminary condition, the German empire, has been created. The second condition is also present. German commerce flourishes and develops, and it can only develop in prosperity and safety when it feels safe under the imperial power. Imperial power means naval power, and naval power and imperial power are implicitly dependent on each other; the one cannot exist without the other."

Besides, it is not only Germany who increases her navy; everywhere we see the same thing. To all commercial nations a strong navy is of vital importance. For Germany, the increase of her navy will cost about £20,000,000 (400,000,000 marks), extending over a number of years.

The construction of these ships has, of course, contributed to the activity of Germany's industry, already so busy. This is amply proved by the movement of the iron trade.

The imports amounted, in tons, to—

In 1898.		In 1897.	In 1896.	In 1895.
523,807	against	564,745	421,426	258,227

The exports amounted, in tons, to—

In 1898.		In 1897.	In 1896.	In 1895.
1,626,130	against	1,392,953	1,518,620	1,527,894

That is to say that the exports of 1898 exceeded those of 1897 by 233,177 tons, or nearly 77 per cent. It will be seen from these figures how favorable the situation of the iron industry is, which is due to the active demand for machinery, the construction of railways, and also to the demands of electricity, the development of which is increasing more and more in Germany.

Indeed, one can safely maintain that in electricity Germany is at the head of all nations. According to the Bulletin de l'Office du Travail, the length and the number of cars of electric rail and tramway lines in Europe was as follows:

	Length in Kilometers.		Number of Cars.	
	1897.	1898.	1897.	1898.
Germany	642·69	1,138·20	1,631	2,493
France	279·56	396·80	432	664
Great Britain and Ireland	127·45	157·20	195	252
Italy	115·65	132·70	289	316
Austrja-Hungary	83·89	160·50	194	243

The German banks naturally found in the development of commerce and industry a vast field for their activity. Their issues amounted to—

In Millions of Marks.				
1894.	1895.	1896.	1897.	1898.
1,419	1,374	2,088	2,013	2,697

of which—

In Millions of Marks.				
1894	1895	1896	1897	1898
168	389	535	668	1,002 were in various stocks.
203	43	34	25	146 were in German loans.
189	73	333	167	326 were in foreign loans.
95	229	307	283	477 were in industrial shares.

These are big figures, and it would be rash to say that all these issues were successful. Here it will be well to remember the words of the great French financier, Isaac Pereire: "Souscrire n'est pas placer et placer n'est pas classer."

But, on the other hand, it must not be forgotten that the extensive development which commerce and industry has taken in Germany has greatly benefited the German people. Many fortunes have been made, and from the middle classes these fortunes have spread rapidly to the working classes.

Already, in 1893, the well-known German professor, Schmoller, declared before the investigation committee of the Bourse that, working on official statistics, he found that the German nation saves every year between 2,000 and 2,500 millions of marks, of which 1,000 millions were invested in stocks, but since 1893 the general wealth has greatly increased, as is proved by the official statistics showing that during the last three years the income and value of property in Germany has increased nearly three milliards of marks, and by the ever-increasing receipts of the savings banks, which in 1893 were only 798 millions, in 1895 already 981 millions; in 1896, 1,039 millions; and in 1897, 1,082 millions of marks.

These and other statistics show clearly that the purchasing power of the German nation has largely increased. Besides, the conversion of German and foreign government stocks induced the greater part of the public, not satisfied with the moderate interest offered, to desert this sound department of the Bourse,

* According to a statement made by Count von Posadowsky, Secretary of State for the Interior, in the Reichstag on February 11, 1899, in 1890 American imports from Germany amounted to $99,000,000, in 1896 to $94,000,000, in 1897 to $111,000,000, an exceptional increase due to the special circumstance of the sugar trade, but in 1898 imports from Germany had declined to $70,000,000. In 1890 American exports to Germany had reached the value of $86,000,000, in the financial year of 1898 they had increased to $155,000,000. The balance of America's trade with Germany in favor of imports had in 1890 been $13,000,000; her balance of trade in favor of exports to Germany has now reached $85,000,000.

and to take up industrial shares, thinking that against the greater risk attending these shares there was, on the other hand, a chance of big dividends and higher quotations.

GRAPHITE: ITS FORMATION AND MANUFACTURE.*

EARLY HISTORY AND RECOGNITION.

IN the year 1779, Karl Wilhelm Scheele, a young apothecary in the town of Koping, Sweden, a remarkable genius as an investigator, and then in the 37th year of his age, discovered that graphite had an individuality quite apart from molybdenum sulphide, with which it had been until then confounded. He discovered that when it was treated with nitric acid, carbon dioxide was produced, whereas molybdenum sulphide when oxidized produced a white earth, and he drew the conclusion that it must be some kind of carbon, likely of the general nature of coal.

Previous to this discovery by Scheele, a group of minerals including graphite and certain ores of lead, molybdenum, antimony and manganese (lead sulphide, molybdenum sulphide, antimony sulphide, manganese dioxide), were believed to be one and the same substance, or, at least, members of the same family. This opinion was due to their outward resemblance, and the fact that they produced marks on paper. This confusion naturally led to the application of the same name or names to each of the members of the group, and as graphite had not been recognized by any peculiarity distinctively its own, it received the names molybdæna, plumbago, graphite and black lead, which were used in an indiscriminate manner for each of the several substances. The name molybdæna was dropped at an early date, probably immediately following the discovery by Scheele, and there is no known reason why plumbago and black-lead should not have followed its lead, for graphite is the only one of the series not misleading and entirely appropriate, meaning as it does "I write," from the Greek word $\gamma\rho\upsilon\varphi\omega$.

Graphite does not seem to have received any particular attention from chemists from the time of the discovery by Scheele until the year 1800. During the last quarter of the eighteenth century, the diamond was a subject of much interest, in a chemical sense, and in the hands of the French chemists it was shown to produce carbon dioxide when ignited in air. In 1796 Smithson Tannant showed that equal weights of charcoal and diamond yielded equal weights of carbon dioxide on burning, and they were thereafter associated together as carbon. In 1800 Mackenzie added graphite to the carbon group, by showing that it also, in equal weight, produced the same weight of carbon dioxide.† Thus, in the opening year of the present century, graphite was proved to be an elementary substance. Charcoal, diamond and graphite were then recognized as three distinct allotropic forms of the element carbon.

DISTRIBUTION.

Graphite, in a more or less pure state, is quite freely distributed over the earth, but only in a few places is it found under conditions of purity, quantity, ease of mining, refining and transportation to market that permit of a profitable business being made of it. Statistics for the six years 1890 to 1895, inclusive, give the world's production as 73,751, 57,220, 54,280, 55,810, 46,951 and 53,955 short tons. This is an average yearly production of 56,994 tons—over 156 tons every day of the year—of a material known to the majority of men as black-lead or plumbago, useful only for writing on paper and polishing stoves.

The production during the years mentioned was contributed to by Austria, Ceylon, Germany, Italy, United States, Canada, Japan, India, Russia, Great Britain, and Spain, the proportionate quantities furnished by these countries being in the order given.‡ It will be observed that Great Britain is, with but one exception, the smallest producer; indeed, 45 tons cover the total amount reported, and this was mined in 1895. For several centuries Great Britain was one of, or the largest producer; in fact, in the earliest days of the industry, it was probably the only one. The graphite from the Borrowdale mines in Cumberland was famous as the best for making pencils. In the sixteenth and seventeenth centuries these mines were so productive as to yield an annual revenue of £40,000, although they were only worked a few weeks in the year for fear of exhausting them.§

Great differences exist in the structure and purity of the graphites furnished from the various mines. Mother Nature was seemingly not content with making carbon appear in three forms, charcoal, diamond and graphite, but extended her labors on graphite; and, to the further confusion of the metallurgist and the chemist, made it a family of two members, crystalline and amorphous, two distinct allotropic forms of the allotropic substance, graphite. The product of the Ceylon mines is crystalline, of great purity, analyzing in some instances over 99 per cent. carbon, while that of the Borrowdale mines is amorphous and also very pure.

The chief impurity in graphite is iron; indeed, its constant presence and frequent large quantity led to the belief, in the early days, that graphite was a carbon-iron compound, and it was even sometimes called carburet of iron.

USES.

It is quite probable that the first use made of graphite was as an instrument of writing. The first account we have of its employment for this purpose is contained in the writings of Conrad Gessner on Fossils, published in 1565. A picture of a pencil is shown, and, referring to it, he says: "The pencil represented below is made, for writing, of a certain kind of lead (which I am told is an artificial substance termed by some English antimony), sharpened to a point and inserted in a wooden handle."‖ This pencil was probably made of graphite from the Borrowdale mines, which, we are told, were in operation in the sixteenth century. Its uses for other purposes than pencils are of much more recent date, probably all of them falling within the present century, and nearly all within the last few years.

The present uses of graphite include the manufacture of pencils, crucibles, stove polish, foundry facing, paint, motor and dynamo brushes, anti-friction compounds, electrodes for electro-metallurgical work, conducting surfaces in electrotyping, and covering the surfaces of powder grains. For most of these purposes it is used in the natural impure state, while for others it is necessary to render it quite pure and free from grit. Its purification is accomplished by a method worked out by Brodie, which consists in first grinding or otherwise reducing the graphite to a state of fine subdivision, washing out the heavier impurities, mixing 14 parts with 1 part of potassium chlorate and 2 parts of concentrated sulphuric acid, heating on a water-bath for some hours, washing thoroughly and afterward roasting at a red heat. If silica is present, a treatment with hydrofluoric acid is added to the process.

The mining and manufacture of graphite into articles for which it has been found useful give employment to thousands of people. The mines of Ceylon alone, when working to their capacity, employ about 24,000 men, women and children; the work, however, is done entirely by hand, and in a very crude manner.* In the city of Nüremberg, Germany, the home of the famous Faber pencil, are twenty-six factories, employing about 5,500 people in the making of pencils.†

MANUFACTURE.

The rapid increase in the use of graphite, and consequent decrease in Nature's stocks, make the problem of manufacturing it to order a subject of much importance.

When we consider the hundreds of thousands of chemical changes men are constantly putting the elementary bodies through, and the very prominent part taken by carbon in these reactions, it would be rather remarkable if at some point Nature's method for producing graphite was not discovered. That it is not a very difficult act is evident from the fact that it has been accomplished, in a small way, in several instances.

Mr. Muir, in Watt's Dictionary of Chemistry, edition of 1890, mentions six recognized methods.

(1) By heating charcoal with molten iron, and dissolving out the iron with hydrochloric and nitric acids.

(2) By the slow decomposition of hydrocyanic acid, and boiling the product with nitric acid.

(3) By evaporating the mother liquors obtained in making soda; these contain cyanogen compounds which are decomposed at a certain concentration of the liquid with formation of ammonia and graphite.

(4) By leading carbon monoxide over ferric oxide at 300° to 400°.

(5) By the decomposition of carbon disulphide at high temperature, in contact with metallic iron.

(6) By leading carbon tetrachloride over molten pig iron.

Whether or not any of these methods could be developed to a state providing a commercial process, I am not prepared to say, but am inclined to think not. They have always been considered accidents or chemical feats of the laboratory, and in some instances their formation was very objectionable.

The Cowles Bros., of Cleveland, O., are reported to have found that graphite sometimes occurred in or about the charge of an electric furnace. This formation is referred to in one of their patents, and a feature of the patent is a provision to get rid of the material, as it was very objectionable on account of its high electric conductivity. Its formation was not reduced to a method, the causes for, or the exact conditions under which it was made, not having been investigated. It was like some of those in the list of Muir, an accident, and a great nuisance.

Still another way of making graphite was described by G. Rose, in 1872. He exposed a cut diamond bedded in charcoal to a temperature equal to molten cast iron, whereupon the surface became coated with graphite. It is safe to say this process will never attain commercial success nor popularity.

Finally, in the Encyclopædia Britannica (1890) we are told that "by heating to the high temperature afforded by a powerful galvanic battery, both the diamond and amorphous carbon are converted into graphite." This statement I will refer to later on.

In a paper which I had the honor of presenting to the Institute at its stated meeting of June 21, 1893,‡ reference was made to the formation of a black material consisting of a mixture of carborundum and free carbon during the operation of the carborundum furnaces. This was again referred to, and at much greater length, by Mr. Francis A. Fitzgerald, chemist to the Carborundum Company, in a lecture delivered before the Institute on December 11, 1896,§ after it had been the subject of much thought and study, and when I had about concluded the formulation of a theory covering the transformation of amorphous into graphitic carbon.

Very early in my experiments on the manufacture of carborundum, I noticed that graphite occasionally formed in the portion of the furnace charge lying next to the cylinder of granular amorphous carbon, which passed through the center of the furnace, and which became heated to an extremely high temperature, by the passage of a heavy electric current, and around which the charge was placed to receive the heat necessary for the formation of carborundum. Also that when ordinary bituminous coal coke was used to form the core, quite a large amount of it was converted into graphite, whereas, when petroleum coke was used, very little of it was made graphitic.

By a careful study of these formations, it was found that the graphite formed outside of and surrounded the core, was produced by the decomposition of the carborundum, which is, chemically, a carbide of silicon, and, by induction from a number of known facts, that that formed within the core was also produced from a similar decomposition of carbides, which were created by the chemical union of the carbon of the core with its contained impurities. The facts from which I have drawn this conclusion are:

(1) Comparatively pure petroleum coke produces practically no graphite.

(2) Impure bituminous coal coke produces large quantities.

(3) The larger the known percentage of impurities in the bituminous coal coke, the greater the amount produced.

(4) That only a part of the carbon of the core is converted into graphite. This not being increased, even by repeated use of the same grains, in successive carborundum furnaces.

The graphite formed by the destruction of carborundum is remarkable in that it retains the form of the crystal of carborundum from which it is derived. It has, however, less than one-third the weight of carborundum and possesses the characteristic metallic gray color of natural graphite, but in size and form it so closely resembles the original crystal as to be, in fact, its skeleton pseudomorph in graphite. The graphite formed in the core is usually not so well defined, or distinct, as in that from carborundum, most of it being disseminated through the body of the individual grains in which it is found, the amount contained in any one grain varying with the percentage of impurity originally present. In some instances, the entire mass of the grain is converted into beautiful graphite, this occurring, I think, in cases where the grain is largely composed of slate, and it sometimes happens that one-half of the grain is completely converted, while the remainder is changed but little.

These two seemingly distinct methods of producing graphite from carborundum and from coke are, in fact, identically the same; the first step in each is the formation of a carbide, the second its destruction. In making carborundum, silica and coke are mixed in the correct proportions to produce a true carbide, when heated in the electric furnace, without an excess of either constituent. In making this mixture, account is taken of the impurities contained in the coke, and the silica reduced proportionately. In the case of the core, there is a natural mixture that produces a carbide from a portion of the carbon. The carbides formed under both of these conditions decompose when heated to a certain temperature above that at which they were formed.

This method of manufacturing graphite I would define as consisting in heating carbon, in association with one or more oxides, to a temperature sufficiently high to cause a chemical reaction between the constituents, and then continuing the heating until the combined carbon separates, in the free state. It is not, however, limited to the use of oxides, as pure metals, their sulphides and other salts may be used; but for various reasons the oxides are to be preferred.

THEORY OF FORMATION.

All of the methods of manufacture, thus far known, contain the same underlying, fundamental principle. Each of the six methods described by Muir, as well as my own method, contain as a part of the process the expulsion or liberation of the carbon from a chemical association with one or more elements, and this occurs under conditions unfavorable to, or absolutely prohibitive of, its reassociation with the same or other elements. It is cast out, free to take unto itself such physical or other properties as we must assume properly belong to it in the free state, when formed under normal conditions. It has been shown by Moissan that when subjected to great pressure, at the moment of separation from cast iron, carbon has those distinctive characteristics that cause it to be called diamond, while Scheele showed, in 1778, that the same carbon, separating from the iron without pressure, takes the graphitic form. Amorphous carbon, the third allotropic form, never occurs pure and is invariably produced from carbon held in chemical association with other elements, under conditions favorable to free chemical action between it and other elements.

The production of graphite by Rose's method—heating a diamond bedded in charcoal to the melting-point of cast iron—is a beautiful illustration of the return of a body under strain to the form it takes under normal conditions. It will be noted that the diamond was heated to the temperature at which it is known to form, as shown by Moissan's experiments; also that it was fairly well protected from chemical action.

The statement in the Encyclopædia Britannica that both diamond and amorphous carbon are converted into graphite, when heated by a powerful electric current, is very commonly held, indeed, I might say universally, although Berthelot concluded, from his investigations, that heat alone is without influence on carbon: that is to say, graphite is not changed to amorphous carbon, nor the amorphous to graphite, when heated to whiteness in an atmosphere of hydrogen or chlorine. That diamond will change to graphite, when protected from chemical influences, under the influence of high temperature, is undoubtedly true, and, indeed, is what might be expected from other known facts; but that pure amorphous carbon will change to graphite as the simple result of heating is not proved, and certainly it does not occur at, or below, the temperature necessary for the transformation of the carbon in a carbide to graphite.

From the facts in hand, I have deduced the following theory:

(1) Graphite is the form carbon assumes, when freed from chemical associations, under conditions of low pressure and protection from chemical influence.

(2) Diamond is the form carbon assumes, when freed from chemical associations, under conditions of high pressure and protection from chemical influence. And, by inference—

(3) Amorphous carbon is the form carbon assumes, when freed from chemical associations, under conditions of low or high pressure and exposure to chemical influence.

This theory does not, however, account for all of the observed facts, and must be supplemented by the hypothesis that catalysis occurs, under certain conditions, during the transformation of amorphous into graphitic carbon. The amount of graphite produced in the core of a carborundum furnace, and also in graphite articles I have made, is much too great to be accounted for by the theory that it is formed by the dissolution of the fixed carbides, formed by the contained impurities and carbon sufficient to satisfy the chemical formula. The most probable and satisfactory explanation is that a catalytic action occurs—a progressive formation and dissolution of carbides. The temperature being much above the point of volatilization of silica, and all other possible impurities, a rapid dissi-

* Paper read before the Franklin Institute, May 18, 1899, by E. G. Acheson, member of the Institute. From the Journal of the Franklin Institute.

† Roscoe.

‡ Mineral Industry, 1898.

§ Roscoe.

‖ Roscoe.

* "Watt's Dic. of Chem.," 1890.

† "Encl. Brit."

‡ "Carborundum: Its History, Manufacture and Uses."

§ "The Manufacture and Development of Carborundum at Niagara Falls."

pation of the active agents takes place and is completed, in this case, before the conversion of all of the amorphous carbon can occur.

COMMERCIAL MANUFACTURE.

As the result of my investigations and deductions, I think the only commercial way to make graphite is by breaking up a carbide by the action of heat. The carbon should be freed from chemical combination by what might be termed the evaporation of its associated elementary substances. I have secured patents covering this method, and these have been made the basis for the organization of an incorporated company, bearing the name "Acheson Graphite Company." The company has now under way the erection of works at Niagara Falls, where the necessary electric current will be obtained from the Niagara Falls Power Company.

Several distinct forms of the product will be produced. One consists of forms of articles, made out of amorphous carbon, with the desired amount of impurity added thereto, which will afterward be heated in an electric furnace and converted, more or less, into graphite. I have been carrying on this line of manufacture for a year or more, using the furnaces of the Carborundum Company to produce the graphitization, the articles having first been made by the arc-light carbon manufacturers. Over 200,000 carbon electrodes, measuring 15 inches in length, with about 1 inch cross-sectional area, were made for use in the Castner alkali process, nearly one-half of them having been shipped to Europe, to be used for this work in England and Germany. The life or efficiency of these graphitized electrodes is many times that of the same electrodes ungraphitized. I have also graphitized some tons of carbon plates, to be used in making dynamo and motor brushes, and a large variety of odd forms and sizes for divers purposes.

Another product—the one which will probably be of greatest importance—is an intimate mixture of pure amorphous carbon and graphite in fine powder. This will be put on the market for paint and foundry facing, and, as it has been formed at an extremely high temperature, it is quite pure, and possesses all of the qualities desirable for the purposes for which it is intended.

It is not the present intention of the company to enter into the manufacture of their product in finished form for the general market, but rather to encourage those who are now engaged in making up the natural graphite into articles of commerce to become buyers of their material, substituting it for that now used.

The company's plans, now being carried out, provide for the erection of a brick and iron building, 100 × 50 feet, on a plot of ground in Block No. 8 of the Niagara Falls Power Company's lands (adjoining the works of the Carborundum Company). Therein they will erect machinery for reducing coke to grains of the desired size, an electric furnace through which the prepared grains will pass in a continuous stream, a pulverizer for reducing the grains as received from the furnace, and a scalping sieve through which the product from the pulverizer will pass, that particles exceeding the $\frac{1}{100}$ of an inch diameter may be removed. The final flour or powder will contain an amount of pure graphite proportionate to the percentage of impurities in the original coke. It is quite possible that instead of using high-grade, marketable coke, the fine refuse from the coke ovens, which is at present a waste material, will be utilized in the manufacture of this product.

In this connection I would call attention to the need of a specific name for the new product. Artificial, as applied to a product chemically and physically identical with that made by Nature, is not pleasing; it conveys the impression that, failing to produce the real thing, a cheap imitation, a sham, is being palmed off as the genuine article. Not even the Century Dictionary's definition of artificial, as "made or contrived by art, or by human skill and labor; opposed to Nature," is sufficient to banish this feeling; for, after all, in the particular case in hand, being ignorant of the exact methods pursued by Nature, we may be simply forcing her to reveal her methods, to the final results of which we neither add nor subtract one jot or tittle. The same objections may be made to the expression Artificial Manufacture of Graphite, for we may not be sure that the process forced upon her is not identical with that of her own selection. Manufactured Graphite would be quite appropriate, were it not for the fact that it is popularly applied to articles made of graphite.

It may not detract from the general interest in this subject to call attention, in closing, to the fact that graphite, first shown to be an elementary body, an allotropic form of carbon, in the first year of the nineteenth century, is in this, the last year, made to order in great quantities, and that it will, before the close of the century, become an article of ordinary commerce in its new form. Perhaps it will take its place as the primitive form of carbon—the one it assumes under normal conditions.

A learned Swiss anthropologist, recently returned from a scientific expedition to Patagonia, brought back with him a large number of cases containing skulls of the ancient and modern inhabitants of that inhospitable region, and also a few other crania obtained in some of the Pacific Islands. The boxes passed safely through the Italian port to which they were consigned, but when they reached the Swiss border, trouble began. The cases were opened, and the horrified officials were at a loss what to do with the contents. Nothing of the sort had ever been brought to their attention. After several long conferences, however, and much telegraphing between the high officers of government, the custom officials informed the worried scientist that the contents of the boxes would be taxed the ordinary rates of entry of animal remains (bones used in making fertilizers, etc.), so much per kilogramme. The scientist, amused, yet provoked at the picayunishness of the douaniers, implored them to at least give the relics the respect due to human remains. His plea went forward to the chief douanier, and in a day or two, to his great astonishment and delight, there came back from Zurich an order to admit the collection free, as "the effects of emigrants to Patagonia, eaten by cannibals." This story is told as the truth by Le Gaulois. Se non è vero è ben trovato.—National Druggist.

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